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FORESTS AND TREES OF THE WESTERN NATIONAL PARKS

CONSERVATION BULLETIN NO. 6

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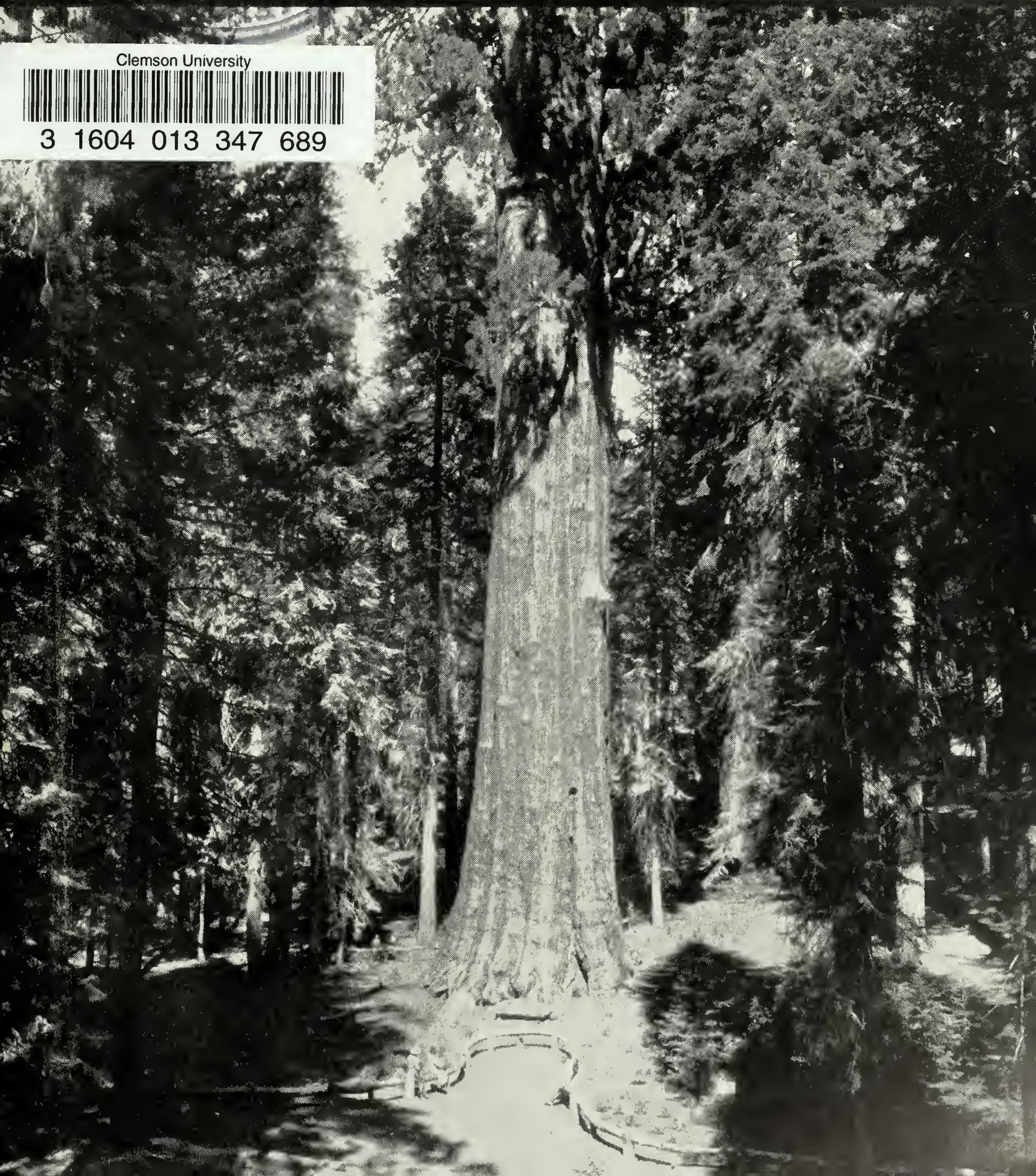

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Forests and Trees
# of the
Western National Parks

BY

HAROLD E. BAILEY

AND

VIRGINIA LONG BAILEY

CONSERVATION BULLETIN No. 6

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Harold L. Ickes, Secretary

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PREFACE

The text for this bulletin was prepared with the aid of material obtained from data collected by the Branch of Forestry of the National Park Service during a vegetation cover survey of the western national parks and from manuscript supplied by the park superintendents. The vegetation survey was undertaken as a project of the Branch of Forestry to obtain data for use in fire-control studies, insect and plant disease control work, administrative planning, and naturalist work. The procedure used was as follows: The boundaries of the vegetation types as seen from high vantage points were sketched in on United States Geological Survey topographic maps. Binoculars were used as an aid in determining the dominant species in each vegetation type. More detailed studies were made in sample plot studies so that the species occurring under the forest canopy could also be recorded.

In 1935 Forester L. F. Cook requested that the men working on the vegetation survey collect all available data while in the field. With this end in view they took photographs of shrubs and trees and wrote reports concerning the forest types. All of this material was made available to the authors, who were connected with the survey for a period of 3 years. Prior to this, in 1933, in answer to requests from the Washington office, the park superintendents sent narrative descriptions of the forests occurring in their respective parks. This material was given to J. D. Coffman, Chief of Forestry, to be used along with data collected on the survey. He has encouraged the work and cooperated in every way in the publication of this bulletin. The photographs of specimens from Crater Lake and Sequoia National Parks were taken by Homer Marion who spent much of his spare time in the field collecting plants and taking pictures. Junior Forester Albert Hawbecker wrote preliminary descriptions of some of the woody plants of the Southwest and, along with Ranger Natt Dodge, contributed to the photographs of the Southwest plants. Other photographs used in the text were taken by George Grant, T. B. Plair, M. H. Mitchell, N. E. Dole, C. A. Hanks, C. A. Wagner, E. Sawyer, D. O. Thomas, and W. T. Frost. Narrative reports of the typemappers, especially those by L. W. Saylor, M. H. Mitchell, D. R. Roseberry, and W. T. Frost, have been freely drawn upon in composing the vegetation type descriptions. Throughout the work, clerical assistance was furnished by the Western Museum Laboratories.

The Branch of Forestry surveys were not the first to be made in some of the parks. In 1926 L. F. Cook and A. E. Wieslander constructed a map of the forests of Sequoia National Park to be used in fire-control studies. In 1931 a vegetation map was started in Yellowstone National Park. In 1932, under the direction of Paul Franke and Don Watson, a map showing the vegetation cover of Mesa Verde National Park was made and in 1934 Frank Brockman completed a similar map of Mount Rainier National Park. In 1930 a map was started as a separate park project in Yosemite National Park and completed in 1936 in cooperation with the Branch of Forestry.

The need for a publication on the trees and shrubs of the western national parks has long been seen but due to lack of definite information on the woody plants in many of the parks no general work of this nature has previously been published. Data as to the extent of forest types, the elevations, locations, and abundance of the trees have only recently been obtained. It has been the aim of the authors to combine interesting facts concerning the trees with not too technical descriptions.

In the tree descriptions the common name is given first, followed by the scientific or Latin name. Where more than one Latin name is given, they are synonyms unless otherwise indicated, the first one having the preferred usage. The Latin name consists of two words; the first, the genus name; the second, the species name. This latter name is often descriptive of some distinctive character of the plant. Scientific names are frequently regarded as stumbling blocks because they are unfamiliar. To the botanist, however, they are essential. Common names are found to be impractical since two or more are often applied to the same plant, or the same common name may apply to two or more plants. Not only is a single Latin name used for each plant, but the same name is applied throughout the world regardless of the place or the language of the botanist.

The descriptions have been almost entirely confined to those features by which the plants may be recognized in the field. Extremely technical terms have been avoided. Additional scientific descriptions may be found in many of the books listed in the bibliography.

Under tree descriptions, occurrences of the tree within the park along with the general elevations occupied are given. The terms used to indicate the abundance of the plants are defined as follows: *rare*, species which are restricted to very small areas or which are represented by a few widely scattered individuals; *occasional*, species which are uncommon or widely scattered or which may be common to a very restricted area; *common*, species which occupy large areas in the park, but which do not occur as extensively as the predominant plants; *abundant*, species which are most common to the park area; *present*, species which are present in the park, but the abundance is unknown.

The word *type* is frequently encountered as one reads the descriptions of the forests and trees. This is a term used by the forester to indicate a particular kind of forested area. For example, forests where the predominant tree is lodgepole pine would be called a lodgepole pine type.

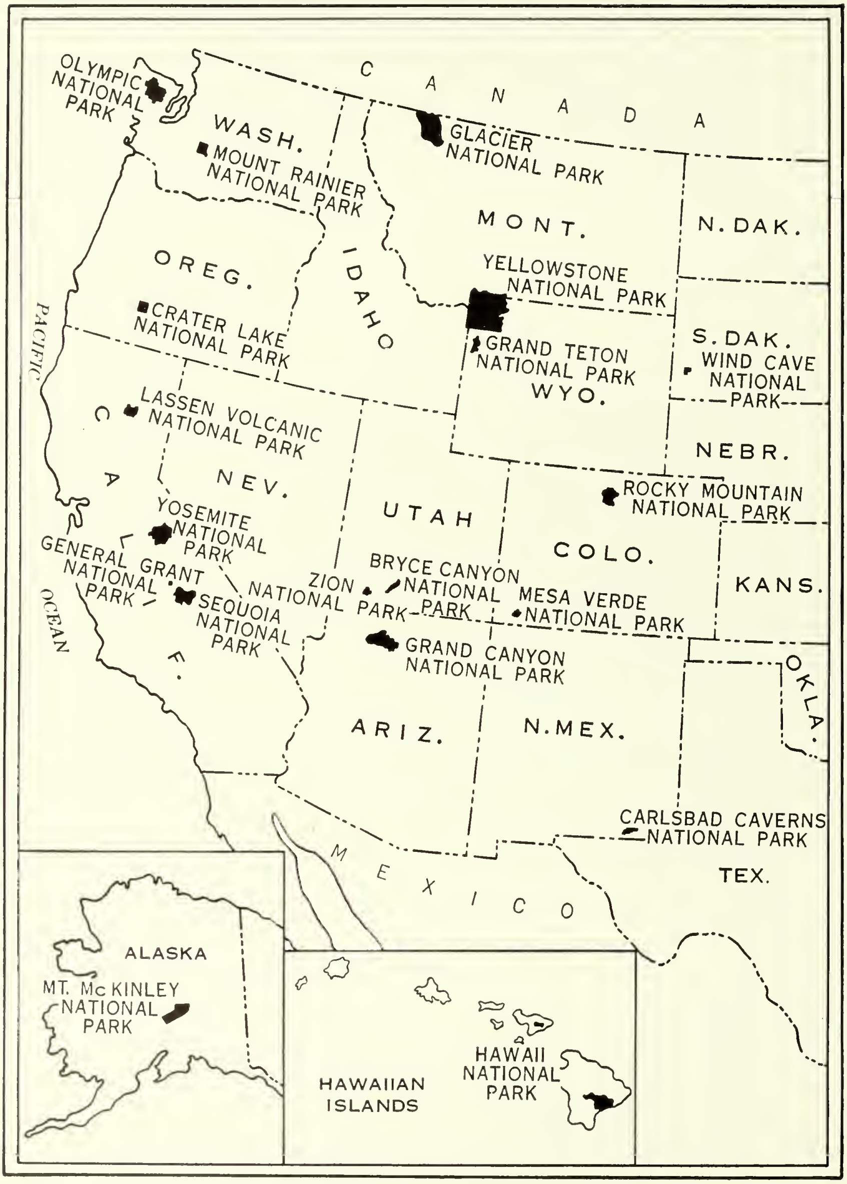

Figure 1.— Map of western national parks.

Forests and Trees of the Western National Parks

Forest Conservation

The history of the forests of the United States is typical of that of many other of our natural resources. Forests were too abundant and too great an obstacle to have value in the eyes of many early pioneers. Besides the waste resulting from cutting trees to obtain logs and lumber for building purposes, the forests represented an impediment in the way of agricultural expansion, and so were frequently destroyed. The trees seemed limitless in extent and there was apparently no need for conservation. However, as the destruction progressed it became apparent to a few men that these were an exhaustible resource and should be conserved.

The western national parks are areas which have been set aside primarily because of their wealth of natural scenery: Crater Lake National Park because of its marvelous deep blue lake; Mount Rainier for the tremendous glaciers; Yellowstone for its wonderful geysers, lakes, and canyon; Yosemite for its magnificant falls and valley; and Grand Canyon for the stupendous canyon and beautiful colors. It is a happy coincidence that rare plant and animal life also are commonly combined with the wonderful scenery in our National park areas.

It is the aim of the National Park Service to retain the primeval and natural forest conditions in the national parks insofar as use and safety of forest will permit. The maintenance of natural conditions excludes the practices of commercial forestry such as pruning and thinning. Within the national parks all native species have a proper place and should not be disturbed. The increased utilization of the parks is ample proof that the use of our forests for recreation is as important as is their economic utilization for timber and as necessary to our physical and spiritual well-being.

Becoming Acquainted With Trees

In each of the national parks a Government naturalist is available to aid visitors in knowing and appreciating the trees and other plants of the area. The novice can learn more in one trip afield with a competent guide than by many days of self-study. A real knowledge of plants, however, is built up only through continual observation and field study, but the time expended will be well repaid by the added enjoyment which one gains. The forest is like a great symphony—one may go and enjoy it without great knowledge, but to gain the full value a background and an appreciation built up through long study are required.

To the park visitor who is not experienced in plant identification it is suggested that he start with the determination of the trees since there are fewer tree species and they are, on the whole, much easier to recognize than are the species of shrubs and herbs. Another advantage is that the general groups, such as the firs, pines, or spruces, are often already known to the park visitor, and this may be used as a nucleus around which to build further knowledge.

An easy means of classifying woody plants has long been looked for and numerous methods have been devised. Lumbermen may classify trees according to various qualities exhibited by the wood. They are often designated as hardwoods and softwoods. The broadleaf trees have hardwood and do not bear cones, while the softwoods (i. e., cone-bearing trees or conifers) have needlelike leaves. However, this classification does not always hold true. Many of the so-called hardwoods, such as the willow, have softer wood than do some of the pines. The California nutmeg and western yew which have needlelike leaves bear fleshy fruits instead of cones. Another common grouping is into evergreen trees (those which retain their leaves for more than one season) and the deciduous trees (those which lose their leaves each fall).

If the stems of trees are closely examined we will find that the leaves are not arranged in a haphazard manner around the stem, but on the contrary, have a very definite arrangement. Some will be found to occur in pairs opposite each other, others are borne singly and alternating with each other on the stem, while still others will be found arranged spirally along the stem. Many forms of leaves may be encountered amongst the broadleaf trees, some being round, oval, egg-shaped, linear, or almost any imaginable shape. Likewise, the leaf-margins may vary greatly. Each species has some feature of appearance or structure by which it may be distinguished from other species. The shape of the leaves and their position on the stem are important characters to be noted in the identification of the species with broad leaves.

Life Zones

Since constant reference is made to the natural belts of vegetation (i. e. life zones) a brief explanation follows. If one were to start at sea level and ascend to timber line he would find progressive variation in climatic conditions. Using these climatic differences as expressed by plant life, the territory may be divided into altitudinal belts or "life zones" marked by a difference in the types of plants found in them. If one proceeds along the Pacific coast of North America from about the state of Sonora in Mexico and travels northward to the Arctic Circle, he will pass through the same life zones as would be found if he started from the same place at sea level and climbed to the top of a high snow-capped peak. The lowest belt of vegetation at the base of the mountain, with a climate typical of the state of Sonora, is called the *Sonoran Zone*. In it are found desert and semidesert types of plants. The next zone, with temperate climate resembling that found in the area covered by the luxuriant coastal forests of California, Washington, and Oregon, is called the *Transition Zone*, since it is transitional between the hot semiarid regions and the *Canadian Zone* which is typical of the timbered regions of Canada. The *Hudsonian Zone* is typified by the tree growth found in the Hudson Bay area in Canada. The *Arctic-alpine Zone* has no trees and the plant associations found there are comparable to those of the arctic regions.

Life zones, as listed above, are not always easily distinguished. They show up beautifully in some places and not at all in others. The line of demarcation between the zones is seldom sharp, but there is a gradual integration of one into the other and many of the plants may be characteristic of two or more life zones. When one can look up hundreds of feet from the Sonoran Zone at the bottom of a canyon such as Zion or Grand Canyon and see the fringe of coniferous trees demarking the Transition Zone forest on the plateau above, the life-zone concept is strikingly illustrated. Where the zones merge or become jumbled, the concept may be perplexing rather than clarifying.

The study of the plants discloses the fact that many species are more or less closely confined to a single life zone. Life zones show up best where the slopes are gentle and extend by degrees from low elevations to high, such as on the west slopes of the Sierra Nevada Mountains of California. Here the slope is more or less gradual, ranging from about 1,000 feet in the lower foothills to an elevation of 10,000 to 14,000 feet on the crest of the range, and the climate has full opportunity to exert the normal influence upon the vegetation. Most of the western national parks exhibit several thousand feet difference between their lowest and highest elevations so that several life zones may be encountered as one follows the mountain trails. A more detailed account with examples of the vegetation occurring in the various zones has been included in the discussion of the forests of Yosemite National Park.

Timber line, the altitudinal limit of tree growth, varies greatly in the western national parks as one goes from south to north. For example, in Rocky Mountain National Park, timber line is approximately 11,500 feet; in Glacier National Park it is about 9,000 feet; in Mount Rainier, about 6,500 feet; while in McKinley National Park in Alaska it is only 3,500 feet. The national parks in the Southwest do not reach elevations high enough to exhibit a timber-line type.

Structure and Functions of a Tree

Although trees are among our greatest resources, few people realize how intricate is their internal structure. A tree is made up of three main parts: the root, the trunk, and the crown. The roots serve to anchor the tree and to supply it with water and certain essential mineral elements. The root system may be very extensive, occasionally exceeding the crown in size. The mesquite of the Southwest, for example, may possess a greater growth below the ground than above. The main stem or trunk of a tree supports the crown and is the system through which water and food materials are transported between the roots and the leaves. The crown is composed of branches and twigs which bear the leaves, flowers, and fruits.

A cross section through the trunk of most trees shows: (1) Outer bark, (2) inner bark, (3) cambium, (4) sapwood, and (5) heartwood. The *outer bark* is a protecting layer. It is continually being sloughed off due to mechanical weathering. At the base of the Sequoias in the Sierra Nevada of California, flakes of bark often accumulate beneath the trees to a depth of many inches. Literally tons of bark weather away during the lifetime of one of these Big Trees. The *inner bark* is the food conducting tissue. If a band of this tissue is completely removed from a tree by girdling, the roots die from a lack of nourishment and the tree finally perishes. The *cambium* is the only tissue which can grow and furnish new layers of inner bark and sapwood. Growth in thickness or diameter is due entirely to the activity of the cambium layer. Growth in length takes place in the terminal growing tissues located at the ends of stems, branches, and roots.

All tissues inside the cambium are termed wood. Two regions can generally be noted, the *sapwood*, which is light in color surrounding the darker colored *heartwood*. The sapwood is so termed because it conducts sap up from the roots to the top of the tree. Many of the cells of the sapwood are living as contrasted with the heartwood which is dead and no longer conducts sap. If the sapwood is destroyed, the tree dies, but a tree may live for years with the heartwood completely rotted away. The latter is important to the tree only for the mechanical support.

If a section of the wood of a tree trunk is examined, it is found to be made up of a series of concentric circles or rings. Each ring represents a year's growth, part of which is composed of large thin-walled cells. The thin-walled cells composing the spring wood are laid down during the early part of the growing season when conditions of temperature and moisture are favorable. The smaller thick-walled cells are laid down during the summer when growing conditions are not so favorable.

Rings vary in width in a given tree or within a given species, depending upon the environmental conditions. A forester can tell a great deal about the growth of a tree by examining the annual rings. If they are wide, it indicates that the tree has grown rapidly; if narrow, the tree has grown slowly, perhaps because of unfavorable weather conditions, or because some other factors under which the tree was growing were adverse. Fire scars and insect damage are often recorded in the heartwood of a tree. While the layers are, generally speaking, laid down at the rate of one each year, the age cannot always accurately be judged by counting the so-called annual rings. A second growth ring may be produced in a single season if the growth is interrupted by drought or by temporary defoliation which may be caused by insects or disease.

A tree is a living organism and as such requires air and nourishment. Air enters the plant through tiny openings in the leaves and smaller quantities are also obtained from the soil. Plants have an advantage over animals in that they have the ability to manufacture their own food from carbon dioxide from the air and water from the soil. During the process, called photosynthesis, sugar is manufactured or "synthesized" with the energy furnished from sunlight in the presence of a green pigment, chlorophyll, found in the leaves of green plants. The synthesis of sugar from these raw materials has never yet been accomplished in the laboratory by man. All animals are dependent directly or indirectly upon plant life for food.

With such trees as the Sequoia there does not seem to be any evidence that the life of the tree comes to an end through old age. Apparently death is always occasioned by external causes such as disease, insects, mechanical injury, etc. Mechanical injury seldom results in the complete destruction of the tree but generally wounds or weakens it, leaving an opening by which insects and fungus diseases may enter. Fire is one source of mechanical injury. Man, of course, is the arch destroyer of trees, for in addition to cutting the trees for timber he is the chief cause of fire. The effects of fire may be to kill the tree directly by killing the growing cambium of the trunk or it may merely be to wound or weaken the tree which, although it may appear green and healthy for as long as 2 or 3 years, may later succumb.

There is a constant struggle among forest trees to get above the forest canopy and to obtain a maximum of the essential light. In areas of dense reproduction the dominant trees may grow more rapidly than their associates and as the shade which they produce deepens, the suppressed growth is left behind. In the dense forest, where the tree crowns interlace to form a complete cover, the lower branches which cannot secure sunlight die and fall off the trunk. This is why the forest trees have clean trunks free of lower branches. Trees grown in the open have an entirely different outline with the lower branches sometimes touching the ground. Forest trees do not tend to exhaust the soil as many people imagine but, on the contrary, they add to the soil a great deal of organic matter which forms humus and in time increases the fertility of the soil.

Plant Associations And Succession

The forest is not merely a heterogeneous mass of trees, nor does the term refer only to the trees of an area. When one speaks of a forest, he includes the shrubs, herbs, animals, insects, and even the micro-organisms which inhabit the forest floor. These are all an integral part of the forest and must be considered as such, for when the forest goes, by burning or by cutting, all associated plant and animal life goes and different plants and animals take their places.

The greatest interest in the study of plants lies in knowing something of their history and associations. Some plants are hardy and can stand many different environments; others are delicate and require very specific conditions. Some are pioneers and seek out new and uninhabited ground, preferring the bare mineral earth and the desiccating heat of the sun and unbroken strength of the wind; others prefer the shade and seclusion of the forest. The hardy plants may thrive in spite of being trampled and beaten down by the wind while to the others such treatment would mean certain death. Plants follow the maxim that you may know them by their companions and by their surroundings. Even within a particular life zone plants do not grow anywhere that seeds happen to fall, but they are found only in localities which provide very definite conditions which are necessary for growth. Pioneer plants obtain a foothold and prepare the way for others by increasing the humus content of the soil and by providing shade for the seedlings of other species. These latter will eventually crowd out the pioneer plants which have prepared the way for them. This is known botanically as plant succession.

Moisture is probably the most important factor influencing the growth of plants and often determines largely what shall grow and what shall not grow in a given locality. Of course, there are many other factors, such as soil, temperature, slope, and exposure, but none of these need be considered if no moisture is available.

We seldom stop to consider how plants originally came into a given region. They have not always been present. The vegetation of the earth has been subjected to periods of change and to the influence of climate. During the ice age the great sheets of ice from the north, gradually creeping southward, forced the vegetation back with it. Further, the national parks have not always been mountainous as they are now. The region now occupied by the Rocky Mountains was once a great inland sea, extending from the Gulf of Mexico northward and covering much of the central part of the continent. The sea existed here for thousands of years, depositing sediment and forming the rock which now in part makes up these mountains. Finally as the area was gradually raised out of the water the land plants migrated onto the newly formed shore.

Many plants that were once widespread are now long since extinct. The Sequoia is one of the most interesting of the survivors. Because its leaves are now found as fossils in other parts of the Northern Hemisphere it has been called a "living fossil." Living trees of this genus growing in native habitats remain now only in California and the southern tip of Oregon.

That plants are able to migrate is self-evident if one will but note such foreign weeds as the Russian thistle and the dandelion. These plants have "hitch hiked" their way by water, wind, animals, and in vehicles into the areas where they are now firmly established.

Forest Regions

The forests of North America have been divided by the forester into a number of distinct regions. Two great forest regions of the West, the Pacific Slope and the Rocky Mountain regions, are separated from each other by the Great Basin area which lies roughly parallel to the Pacific coast. The Pacific Slope forests are typically dense and luxuriant because the western slopes of the high mountains intercept the heavily laden moisture-bearing winds and keep most of the moisture on the coastal side. This factor, together with the mild temperatures, favors a long growing season. Here the forest types, as expressed by those occurring in our Pacific Slope national parks, may be further divided into those found in the Sierra Nevada and those found in the Cascades area. The latter area, with its much greater precipitation, is favored with more luxuriant forests. In the Rocky Mountain region the precipitation is less, the winters are long and cold, and the growing period is correspondingly short. Consequently the trees are smaller and the vegetation less dense. South of the typical Rocky Mountain region is the area of the "Great Southwest" with spectacular sandstone and limestone formations. Here much of the scenery is the result of the activity of the erosional processes due to torrential rains or cloudbursts, the great relief of the country, the contrasts of heat and cold, and the abrasive action of wind-borne sand. Forest growth is typically sparse.

Taking the natural divisions as indicated by the different forest types, the western national parks may be grouped as follows: [1]

Pacific Slope Region	*Rocky Mountain Region*	*Southwest Region*
Olympic, Washington	Glacier, Montana	Mesa Verde, Colorado
Mount Rainier, Washington	Yellowstone, Wyoming	Bryce Canyon, Utah
Crater Lake, Oregon	Grand Teton, Wyoming	Zion, Utah
Lassen Volcanic, California	Rocky Mountain, Colorado	Grand Canyon, Arizona
Yosemite, California		
Sequoia, California		

This classification is not altogether satisfactory, as is illustrated in the case of Grand Canyon. The ponderosa pine forest is the predominating cover on the North Rim of the canyon and has associate species which are entirely different from those predominating in the piñon-juniper forest on the South Rim, so that these two areas do not rightly belong in the same category. Glacier National Park should more properly be considered as lying in two different regions, the Pacific Slope region and the Rocky Mountain region, since the forest cover occurring on the west side of the Continental Divide is essentially different from that occurring on the east side. The Pacific Slope region shows little uniformity in types, as the predominate vegetation types of the Pacific Northwest differ considerably from those of the California national parks.

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[1] Since localities for the trees of Wind Cave, Carlsbad Caverns, Mount McKinley, General Grant, and Hawaii National Parks were not known, these areas are not considered in detail and so have not been included in the regional divisions.

Pacific Slope Region

The forested areas in the Sierra Nevada and Cascade Mountains are considered together here, for although they are quite unlike in character, the two ranges form a single mountain barrier which is more than 1,000 miles long. The general crest of the Cascade Mountains is from 6,000 to 8,000 feet altitude, much lower than that of the Sierra Nevada to the south, and the high peaks from Mount Baker in Washington down to Lassen Peak in California are volcanic in origin. The general crest of the Sierra Nevada reaches from 12,000 to 14,000 feet elevation in the southern part of the range with a gradual but not uniform decline in altitude along the crest towards the north.

Olympic National Park (835,411 acres) is located in the central part of the Olympic Peninsula in Washington. The peninsula is bounded by the Pacific Ocean on the west, the Straits of Juan de Fuca on the north, and Puget Sound on the east. Although the heights attained are not as great as in many of the other national parks, none of the areas is more rugged. The chaotic mountain mass which lies within the park attains its highest elevation in Mount Olympus which reaches an elevation of 7,915 feet. The west side of the peninsula along the Pacific coast has the highest rainfall of any place in the United States. It is interesting to note, however, that Sequim on the northeast side of the mountains, with an annual precipitation of only 14 inches, is one of the driest areas on the Pacific coast. Because of favorable climate, deep soil, and excessive rainfall magnificent forests of

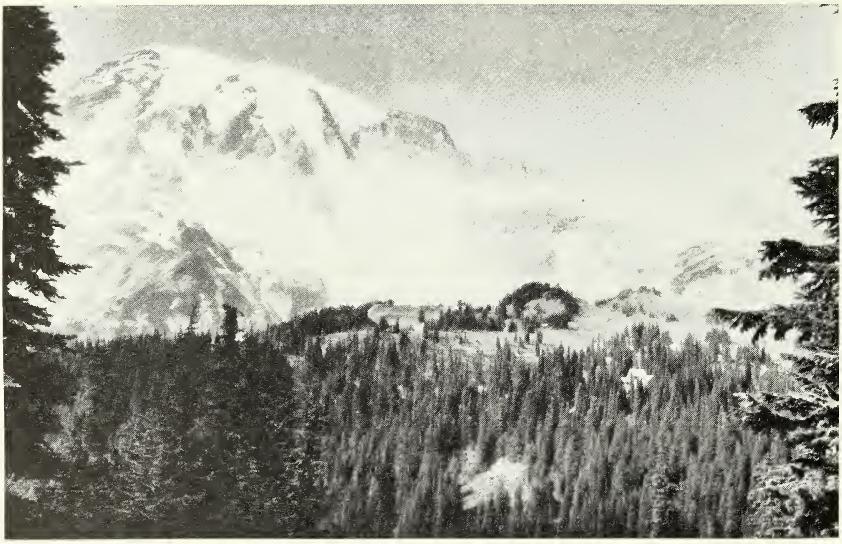

FIGURE 2.—The Paradise Valley region in Mount Rainier National Park is an excellent example of high elevational forests. Mountain hemlock and alpine fir are predominant.

Douglas fir, western hemlock, and western red cedar have developed. Sitka spruce occurs in the dense "rain forests" on the west. When sufficient sunlight filters through the dense canopy, mosses and lichens drape the trunks and branches and, together with the ferns and shrubs, give the forest an almost tropical appearance. Silver fir predominates at middle elevations while alpine fir, mountain hemlock, and Alaska cedar are the common high elevation trees. These often occur in groups in the "mountain parks."

Mount Rainier National Park (241,782 acres) is located a little to the west of central Washington. The precipitation is normally from 60 to 100 inches per year. Here the forests are among the most dense of any place in the United States. At the lower elevations and up to about 3,000 feet they are composed of Douglas fir, western hemlock, and western red cedar. Above this, silver fir predominates in association with noble fir, Alaska cedar, and western white pine. Alpine fir, mountain hemlock, and Alaska cedar are the dominant trees at the higher elevations. Mosaics of grassland with scattered fir and hemlock are common at and just below timber line (fig. 2). Approximately one-fourth of the area is glacier-covered and barren.

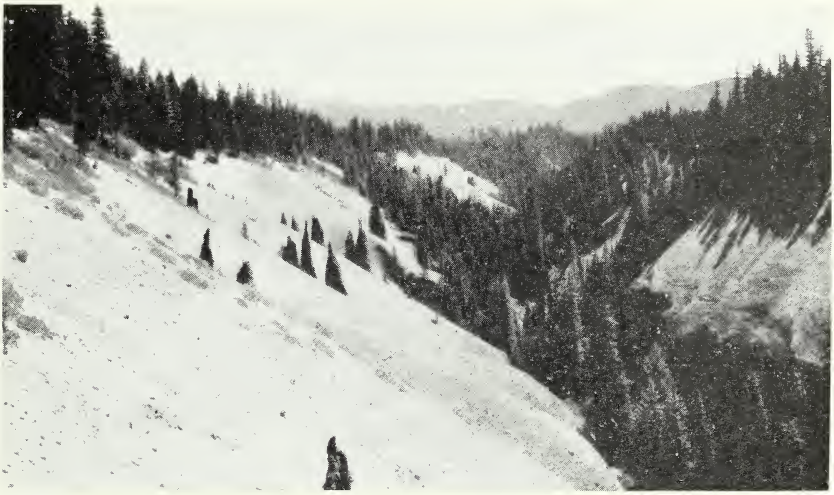

FIGURE 3.—Deep narrow canyons cut the slopes around Crater Lake.

Crater Lake National Park (160,334 acres) is located in the middle Cascades in southern Oregon. The area has moderate to gentle slopes, cut on all sides by narrow ravines and deep canyons (fig. 3). Much of the area is covered with a mantle of pumice, tuff, and other debris. The lake is nearly circular with a diameter of 5 to 6 miles. Surrounding the lake are precipitous walls 500 to 2,200 feet high. The area is forest-covered to the crater rim. The forests are mainly those of the higher elevations but a few species common to the lower elevations intermingle with these at the boundaries or come up into the park by way of the canyons. Lodgepole pine, mountain hemlock, and Shasta fir are the predominant trees, while ponderosa pine, Douglas fir, western white pine, sugar pine, whitebark pine, and alpine fir are less commonly found.

Lassen Volcanic National Park (104,527 acres), located in northeastern California, has the southernmost volcanic peak of the Cascade Range. About three-fourths of the area is forest-covered. Lassen Peak, the largest of the volcanic peaks in the park, attains a height of 10,453 feet. Most of the peak itself is barren. Due to recent volcanic eruptions the park includes many interesting features, among which are cinder cones and lava flows, as well as lakes and meadows produced by the obstruction of older valleys.

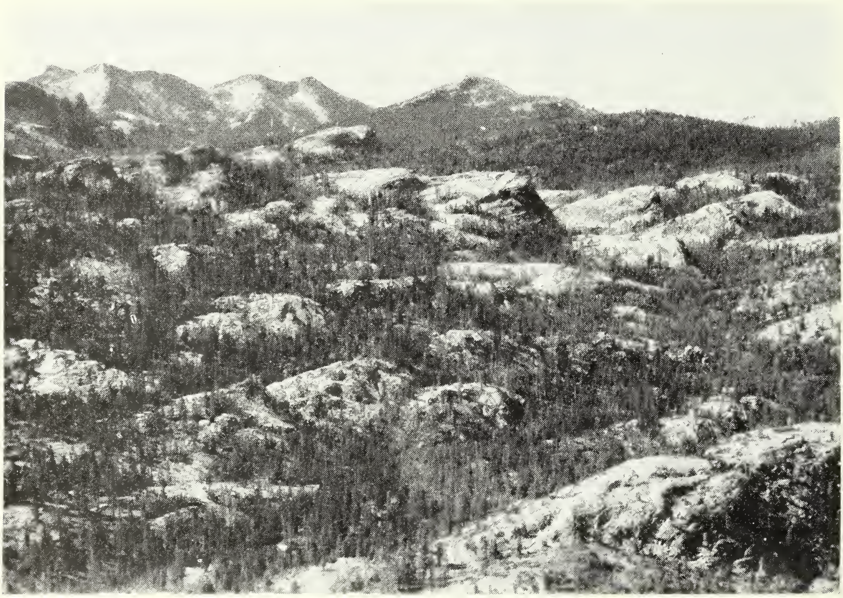

Figure 4.—A view in Yosemite National Park showing rocky slopes from which the soil has been swept away.

Jeffrey pine is the most common forest tree in the park, often in association with mountain hemlock. Red fir, white fir, and lodgepole pine also occur as dominant types or mixed in other types.

If one were to take an airplane ride over the western slope of the Sierra Nevada, in which three of our national parks are located, he would find that the western slopes were clothed with a continuous forest belt almost 500 miles long. White fir, sugar pine, and ponderosa pine compose a large part of the general body of the forest which is bounded below by chaparral and above by red fir, lodgepole pine, western white pine, and Jeffrey pine. The pine and fir forests and a combination of the two make up about one-third of the total forested area. Above 6,500 feet elevation there are many areas of rocky slopes and exposed rock from which the soil has been swept away (fig. 4). In these areas are found such species as lodgepole pine, mountain hemlock, whitebark pine, and western juniper.

Yosemite National Park (761,111 acres) is located in the Sierra Nevada in middle eastern California. The park is cut by two main valleys, the Hetch Hetchy and the Yosemite, running approximately east and west. Both have the unusual feature of flat, broad valley floors typical of glacier-cut canyons. On the western side of the park ponderosa pine, sugar pine, and white fir are the common components of the forest cover. Chaparral and woodland species come in near the western boundary and follow up into the lower valleys. Higher up, towards the eastern boundary of the park, high-elevation types prevail, including whitebark pine, lodgepole pine, mountain hemlock, and Sierra juniper. Many places in the higher portions of the park have been swept bare of soil by glaciers. Here the trees are able to grow only if their roots can penetrate into soil-filled cracks in the granite.

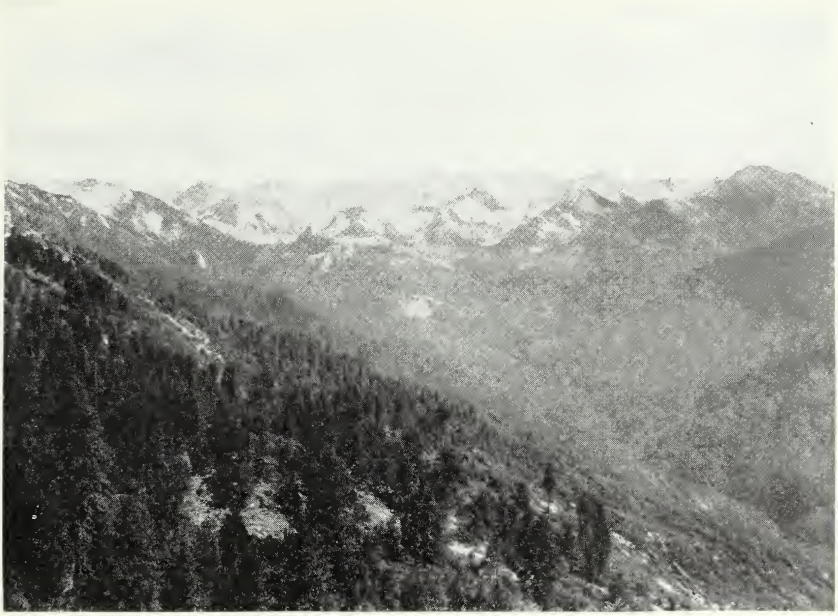

Figure 5.—The Great Western Divide cuts Sequoia National Park into two parts. The Middle Fork of the Kaweah River is in the right foreground.

Sequoia National Park (386,560 acres) is located in the Sierra Nevada 100 miles south of Yosemite National Park. The general outline of the park is roughly rounded but constricted in the middle with the east side of the park separated from the west side by the Great Western Divide (fig. 5). The park is drained by two main rivers, the Kern on the east and the Kaweah on the west. The Kaweah River, running roughly southwest, drains the west side of the divide while the Kern River, running from north to south, drains the east side. The forests on the west side are composed principally of white fir, ponderosa pine, sugar pine, Shasta fir, Jeffrey pine, lodgepole pine, and western white pine. Outstanding are the 30 groves of Sequoias located in this area. The forests on the east side are composed predominantly of lodgepole pine, foxtail pine, and Shasta fir.

Rocky Mountain Region

The Rocky Mountains have been divided into three provinces—the north, middle, and southern—and in each of these is located one or more national parks. In the southern and middle provinces the Rocky Mountains have more or less clearly defined linear crests, while in the northern province they appear more like an extensive plateau which has been cut and sculptured by erosion. The total acreage of the park areas included in this region is several times that of the parks located in each of the other regions. Lodgepole pine makes up about half of the vegetated area of the combined Rocky Mountain parks. The abundance of this species is ample proof that numerous fires have swept over much of the area. Early pioneers are said to have set many of the fires in the Rocky Mountain region to clear land for agricultural purposes and prospectors to facilitate their search for valuable minerals.

Glacier National Park (984,310 acres), located in northwestern Montana, is representative of the northern Rocky Mountain province. The Great Plains stop abruptly at the foot of the range but one can enter into the heart of the park with very little rise in elevation by following the great U-shaped valleys. Glaciation has put the finishing touch on a rugged terrain developed by faulting, folding, and erosion and has produced many features of outstanding interest and scenic value, such as lakes, amphitheaters at valley heads, and peaks with sheer walls several hundred feet high. On the west side of the Continental Divide are areas with forest types which are in many ways similar to those of the Pacific Northwest, while on the east side the forests have the characteristics of the Rocky Mountain types. As in the other national parks of the Rocky Mountains, lodgepole pine forms the most important type at lower elevations. At higher elevations alpine fir predominates, often in association with Engelmann spruce to form the spruce-fir type. These species together cover an area equal to that covered by lodgepole pine. Western larch is a predominating type at low elevations on the west side of the Continental Divide, occurring with Douglas fir in about half of the area occupied.

Yellowstone National Park (2,221,773 acres) is located in northwestern Wyoming in the middle province of the Rocky Mountain region. The central portion of the park is essentially a broad, volcanic plateau most of which lies between 7,000 to 8,500 feet elevation and is drained chiefly by the Yellowstone River and its tributaries. The Continental Divide traverses the plateau, but it is inconspicuous here. Surrounding the central portion, except on the western side, are mountain ranges rising 2,000 to 4,000 feet above the level of the enclosed tableland. The broad expanse of the plateau is largely covered by lodgepole pine which forms the predominant forest at middle elevations, covering about 70 percent of the total park area. Alpine fir and Englemann spruce occupy the zone above the lodgepole pine belt and make up about 7 percent of the total vegetation cover. Douglas fir is common at middle elevations, particularly in the northern part of the park. At timber line and just below whitebark pine occurs.

Grand Teton National Park (96,000 acres) is located only a few miles south of Yellowstone National Park in the most rugged portion of the Teton Range. This mountain range, rising abruptly from 6,000 feet to more than 13,000 feet, extends for 27 miles in a north-south direction. Though small in area, it is one of the most majestic parts of the Rocky Mountains. Approximately one-third of the park is barren and lies above timber line which occurs at about 10,500 feet elevation. The eastern face of the range is deeply gashed by numerous steep, narrow, glacier-cut canyons. Lodgepole pine is the dominant species on the flats and lower moraines up to about 8,000 feet. Above that alpine fir and Engelmann spruce form pure or mixed types which are common up to timber line, often in association with whitebark pine. The vegetation types in the park are relatively small and the life zones are much less definite here than in the Pacific Slope region. Part of the area below timber line, although favorable for forest growth, has been burned over and is temporarily covered with herbaceous or shrub species.

Rocky Mountain National Park (259,416 acres) is located in north-central Colorado. The area embraced is a high peneplain along which extends a mountain range which includes peaks rising 12,000 to 14,000 feet above sea level. Longs Peak (14,255 feet) is the highest in the park. The Continental Divide traverses the length of the park, cutting it into two sections, with the mountains descending precipitously on the east side but sloping more gently on the west. Lodgepole pine forms the most extensive forest cover at the lower elevations, with ponderosa pine occurring occasionally in the valleys at about 8,000 to 9,000 feet elevation. Above this Engelmann spruce and alpine fir form the spruce-fir forest which occurs up to timber line, embracing an area equal to that covered by lodgepole pine. Limber-pine and Douglas-fir forests are also found in the park but are much less common. Above timber line lies a great expanse of low alpine shrubs and herbaceous plants which are of utmost importance for the summer range of elk.

The national parks of the Southwest are located in the region of the high Colorado plateaus which are drained by the Colorado River. The areas are outstanding because of the high elevations which, in general, are above 5,000 feet except where deep canyons have been cut into the tablelands. The horizontal sandstones, limestones, and shales forming the strata in this region are easily eroded by the frequent heavy rains. The climate is hot and dry, with the temperatures and rainfall varying greatly according to the rise and fall of elevation. Below 7,000 feet elevation the yearly rainfall is very scant.

The vegetation of the lower areas is comparatively sparse. Only those plants which are able to withstand very arid conditions grow here. Grasses, cacti, and other desert plants occupy the lower slopes while cottonwoods and willows follow the permanent streams. The composition of the timber types is comparatively simple as compared to the Pacific Coast and Rocky Mountain regions. At elevations of 5,000 to 7,000 feet the piñon-juniper forest is the predominating type while ponderosa pine is the main forest type at the higher elevations. Douglas fir and white fir occasionally form types in Grand Canyon and Bryce Canyon National Parks. The sagebrush type covers about 6 to 7 percent of the area in most of the parks of the Southwest, and the timberland chaparral type occurs to about the same extent, except at Mesa Verde where it is much more abundant.

Mesa Verde National Park (51,334 acres), located in southwestern Colorado, lies on top of a high plateau which rises abruptly above the arid Montezuma Valley, forming a steep escarpment 2,000 feet high. This tableland slopes from about 8,000 feet elevation at the north end to an elevation of about 6,000 feet at the south end. The whole area drains into the Mancos River to the south by means of nearly parallel canyons cutting the southern end of the plateau into ribbonlike strips. The vegetation cover in the southern half is principally piñon pine and Utah juniper interrupted on the talus slopes by patches of sagebrush and considerable chaparral. In the northern part of the park are extensive areas of timberland chaparral broken up by small patches of grassland and sagebrush.

Zion and Bryce Canyon National Parks are located in the "high block plateaus" of Utah which are in the northwestern part of the Colorado Plateaus. These descend to the southward by a series of cliff-rock terraces which are generally not more than 10 miles wide and range from a few hundred to 2,000 feet in height. They are much dissected with many short canyons and amphitheaters. In this area may be found the series of the famous colored cliffs, including the Pink Cliffs, White Cliffs, Vermilion Cliffs, and Chocolate Cliffs. Several of the areas are characterized by very ornate formations resembling colonnades, panels, and buttresses.

Bryce Canyon National Park (35,980 acres) occupies an area which is a part of the Pink Cliffs formation, presenting precipices 800 feet high along the eastern edge of the Paunsagunt Plateau. Ponderosa pine is the principal tree cover on the plateau. The canyons support, primarily, a stunted growth of piñon pine and Utah juniper interspersed with scatterings of chaparral. White fir and Douglas fir also occur in several areas. Since there are no large permanent streams, the woodland type is almost lacking.

Zion National Park (86,343 acres) is a section along the southern edge of the Markagunt Plateau into which the Virgin River has cut the spectacular Zion Canyon with its walls 2,000 feet high. There are many intricately branched canyons, but not many of them have permanent streams. The talus slopes of the canyons are largely covered with the piñon-juniper and scrub-oak types while on the plateaus ponderosa pine predominates, usually associated with shrubs.

Grand Canyon National Park (645,120 acres), the best known of the national parks of the Southwest, is located in northern Arizona to the south of high plateaus of Utah. The canyon has been cut into a high forest-covered plateau which is surrounded by a semiarid region of bare cliffs and desert plains. The elevations of the park range from 1,850 feet at the bottom of the canyon to about 9,200 feet on the North Rim. In the depths of the canyon, which is typical of the lower elevations, the winters are mild and the yearly rainfall not more than 7 or 8 inches. Here the vegetation is typical of the hot desert regions to the south. The higher elevations receive greater amounts of rainfall, while in the highest parts there is considerable precipitation in the form of snow.

The North Rim of the canyon, located along the southern edge of the Kaibab Plateau, embraces the highest and most interesting forested area of the region. Here the elevations range from 7,500 to approximately 9,200 feet, 1,000 to 1,500 feet above the South Rim. The area is characterized by numerous rounded valleys seldom more than a few hundred feet deep, which give the plateau something of a rolling appearance. In spite of considerable precipitation, these valleys are without permanent streams. Magnificent forests of ponderosa pine make up the predominant forest cover here while on the South Rim, which is a part of the Coconino Plateau, the prevailing type is piñon-juniper with ponderosa pine coming in at the eastern end.

Forests of Olympic National Park

Olympic National Park, situated in the heart of the Olympic Peninsula of northwestern Washington, lies in the extreme northwestern corner of the United States. The area of heavily timbered slopes, steep canyons, sweeping ranges, and rushing mountain streams preserves in the virgin state some 835,411 acres of the most magnificent forest and mountain scenery in America. The highest peaks are barren, often surrounded by extensive mountain meadows. Mount Olympus, the highest and most noted peak in the chaotic jagged mountain mass, is indeed outstanding for its many approachable glaciers and the beauty of its setting. To the west lies the Pacific Ocean, the Straits of Juan de Fuca to the north and the Hood Canal to the east. Owing to the proximity of these bodies of water, the climate is typically mild with few extremes of temperatures. The glaciers on the higher peaks are continually being fed by the enormous amount of snowfall which amounts to 250 feet on the top of Mount Olympus.

On the low coastal plain surrounding much of the park there occurs a dense rain forest, much of which has been cut over. The park itself has been but little disturbed by man. Driving around its outer edge one would never suspect that a few miles within lies one of the most scenic mountain areas of the West. Rivers radiate out from all sides of the range like the spokes of a wheel, the principal ones being the Elwha, Soleduck, Bogachiel, Hoh, Queets, Quinault, Skokomish, Duckabush, and Dosewallips.

The forests of Olympic National Park are very similar in many respects to those of Mount Rainier National Park. In both areas one finds most of the forest trees the same. The area may be divided into low, middle, and high elevation types, with species characteristic of each. In the lowland forest Douglas fir, western hemlock, western red cedar and species of fir predominate, with Sitka spruce at the lower elevations in the Hoh River Valley on the west side. Fallen trees covered with mosses are extremely common and wherever sunlight can penetrate the heavy tree canopy dense undergrowth is usually present.

Above the lowland forest lies the middle elevation type with silver fir as the predominating species. Lodgepole pine is encountered in a few places and at higher altitudes where the middle elevation type borders the high elevation forest are found mountain hemlock and alpine fir.

Douglas fir type.—Douglas fir (*Pseudotsuga taxifolia*) is one of the most common and important trees in the park. It generally attains the largest size of any tree in the stands in which it occurs. The most luxuriant forests of Douglas fir are found in the low elevation type but the species ranges on up through the middle elevations, occurring occasionally at the lower margins of the high elevation forest. Pure stands of Douglas fir are found quite commonly in old burns, but the mature forests are usually associated with western hemlock, western red cedar, or silver fir.

Western red cedar type.—Although western red cedar (*Thuja plicata*) does not cover large areas in the park nor form large stands, it is, nevertheless, an important climax species. It frequently forms an understory to the Douglas fir forest, but since the cedar is more tolerant of shade, it will eventually crowd out the Douglas fir. The wood is remarkably durable. The heart wood of fallen western red cedar may remain sound for scores of years.

Hemlock types.—Western hemlock (*Tsuga heterophylla*) is common at low and middle altitudes but seldom reaches an elevation high enough to overlap into the range of mountain hemlock. The species generally occurs with western red cedar or Douglas fir and since it is tolerant of shade, gradually replaces the Douglas fir. Saplings of western hemlock are usually abundant as an understory. Under optimum conditions the tree reaches a large size, at times approximating the size of the huge Douglas fir. The lacy foliage and drooping leader are distinguishing characteristics. In the middle elevation forest silver fir is the most common associate and undershrubs are present wherever the canopy is open enough for light to enter.

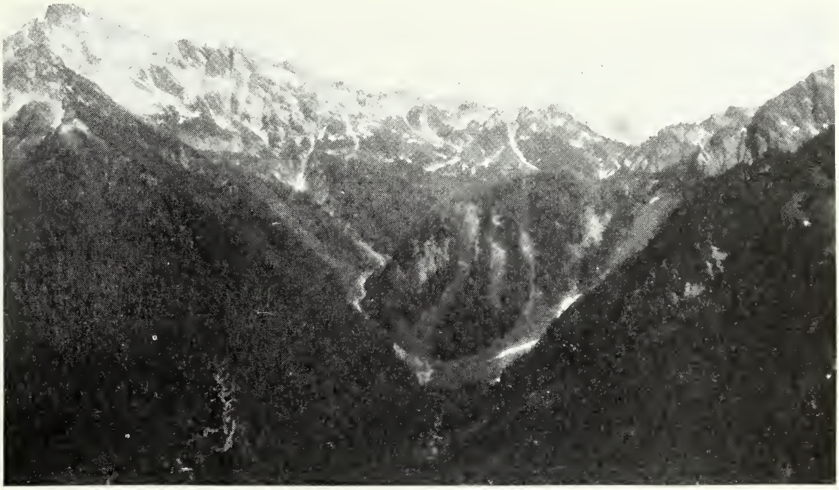

Figure 6.—Looking up Buckinghorse Creek in Olympic National Park showing the shoulders of the mountain densely clothed with silver fir and western hemlock.

Mountain hemlock (*Tsuga mertensiana*) is common only in the high elevation forest where it is usually associated with alpine fir. The windswept bannerlike branches easily distinguish it from the associated alpine fir or Alaska cedar. The tree differs from the western hemlock in the more dense foliage and the wind-swept bannerlike branches. Both are characterized by the nodding top.

Fir types.—Silver fir (*Abies amabilis*) is the common middle elevation tree, but it also occurs at lower and higher elevations. It is not easily distinguished from grand fir but is seldom confused with the alpine fir because of its fuller crown, that of alpine fir being slender and spirelike. Mature silver fir trees in the park seldom exceed 30 inches in diameter nor 125 feet in height. The common associate is western hemlock (fig. 6).

Alpine fir (*Abies lasiocarpa*), the common tree at higher elevations, is frequently associated with mountain hemlock or occasionally with Alaska cedar. Its habit of forming islands of trees in the higher mountain parks has made it one of the most picturesque of park trees. Near timber line the trees are dwarfed or frequently shrublike, sometimes forming mats which may cover many square feet. The forests are generally open with a shrubby undercover.

Alaska cedar type.—Although very similar in general appearance to western red cedar when the trees are of equal size, the two species are seldom confused because Alaska cedar (*Chamaecyparis nootkatensis*) as a type occupies a distinctly different altitudinal belt, being found characteristically in the high elevation forest. The general habit of the foliage is more drooping and at close range the cones, foliage, and bark are distinctive. At timber line the trees are frequently much dwarfed and weather-beaten, usually growing very slowly at such high altitudes. Like the western red cedar, the wood is remarkably durable. Small pure patches of Alaska cedar may be found at and just below timber line.

Forests of Mount Rainier National Park[2]

Mount Rainier National Park is perhaps best known for its great glacial system. Yet without the magnificent forests which occur in the lower portions of the park and the exquisite open parklike areas of the higher parts much of the charm of the mountain would be lost. Coming into the dense forest at any one of the four lower entrances, one first notices the Douglas firs with their dark brown, heavily ridged bark. These superb trees, found on the lower slopes of Mount Rainier, were many years old before the first white man touched the shores of the New World. The great arboreal columns are ancient monuments of the past. Here, as in no other forest of the West, except in the Sequoia forests of California, one feels the stateliness and dignity of the trees. This is rightly so, for no other of our trees, with the exception of the Sequoia, exceeds the Douglas fir in size.

Along with the Douglas fir is the western red cedar with its spreading, fernlike sprays of flattened branchlets covered with scalelike leaves and the western hemlock with its loose, rather lacy foliage. Beneath these forest giants is found a suppressed growth of smaller trees including primarily the silver fir, yew, and western hemlock. Along streams and in other favorable locations the red alder, black cottonwood, and bigleaf maple are found, but these are decidedly in the minority since the forests are typically coniferous.

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[2] Brockman, C. Frank. Report on forest trees of Mount Rainier National Park, 1933. Manuscript.

As the visitor proceeds along the highway, he notices that the great columns of trees are free from branches for the greater portion of their length and wonders concerning this phenomenon. The answer is shade. Growing so close together that their branches interlace overhead, the trees form an evergreen canopy covering the mountain slopes at the base of the great volcanic peak. Only a few rays of sun penetrate into this humid, shaded region and even on the brightest summer days a condition of moist, cool twilight exists upon the forest floor. The effect may be likened to that of diffused rays through a stained glass window of a great cathedral—majestic, silent, and serene. In such a condition the leaves of the lower branches die and fall because of the lack of sunlight, and following this, the branches themselves break from the tree. Wherever sun can penetrate one finds a host of shrubby undergrowth and herbaceous shade-loving plants designed by nature to catch every available bit of sunshine. The moist forest floor and the surfaces of fallen logs are often covered with an exceedingly thick layer of moss, giving the whole area somewhat the aspect of a tropical forest. The combined effect is one of a maze of botanical wealth so varied in its complexity as to be almost confusing; so naturally beautiful as to be almost unreal.

The remarkable development of the forest about the base of Mount Rainier is the result of climatic conditions peculiarly favorable to luxuriant tree growth. The ocean winds that pass through the gaps of the Coast Ranges are laden with moisture which falls in the form of mist, rain, or snow on the west slopes of the Cascades. The mild, relatively short winters and the constant presence of moisture favor a long growing season and thus has been made possible the development of an evergreen forest which is one of the most remarkable in the world.

These same forests which we can admire with such great ease today were for years an almost impenetrable barrier to those who sought to ascend the mountain. It was 41 years after Mount Rainier was first seen by white men before any attempt was made to penetrate into this forest fastness. The first attempt to ascend the mountain is described by Lieutenant Kautz, who wrote: "There was nothing definite except forest of which there was great excess * * *. Our progress was exceedingly slow on account of the undergrowth. * * *. There seemed nothing before us but forest; dark, gloomy forest, remarkable for its large trees and its terrible solitude." This "dark, gloomy forest" of Kautz's time today takes on an aspect of unending interest, of silent magnitude, and of remarkable beauty, thanks to the fine highways which have made the inherent grandeur accessible to everyone and the many inviting trails which give the visitor an opportunity to wind about among the trees, forget the cares of business life for a spell, and enjoy the magnificent solitude of the woods.

When one gets above the 3,000-foot elevation he may notice that there is a decided difference in the forest. In general, the climate is a little more severe and consequently the stand of trees is more open and the trees themselves are not so large; neither is there the undergrowth typical of the damp lowland forest of the Transition Zone. Where the ground is not too heavily covered with litter the forest floor is covered with various ferns such as the swordfern, lady fern, deerfern and oakfern, along with other more or less delicate plants. Western white pine, noble fir, and Alaska cedar occur along with the Douglas fir, western hemlock, and western red cedar, and finally replace them between 4,000 and 5,000 feet. The stand of trees in this middle or Canadian Zone is fairly dense on the flats and benches, but more open on steep, exposed hillsides and wind-swept ridges and in the upper part of the range. Occasionally there is a break in the forest caused by rocky outcrops or steep cliffs and at such points one may catch a breath-taking glimpse of the snowy crest and rocky shoulders of Mount Rainier. Also, in the upper portion above 4,500 feet, there are wide openings made by the deep glacial valleys down which the plants of the higher regions often descend to blend with those of the forest margins.

At about 5,000 feet elevation the visitor literally bursts from the dense growth of trees into open subalpine meadows in which may be found the real floral beauty of the park. Countless colorful flowers covering the slopes in the springtime are admirably set off by symmetrical clumps of the spire-like alpine fir and mountain hemlock with its slender nodding top, and, on the northeast side of the mountain, whitebark pine. Tracts of dense subalpine forest may occur in sheltered locations, but these are nowhere very extensive and their continuity is broken by open grassland. For the most part, the area consists of open parklike areas with compact and symmetrical groups of trees making a lovely setting for the beauty of the mountain.

Why do these groups of trees take the form of such perfect pyramids with the tallest alpine firs in the center of the groups and a gradual gradation to the smaller trees around the edges? The explanation is simple. The cones of these trees ripen in the fall and scatter their seeds to the ground. At about this same time the first snows come and hold the seeds at the base of the parent trees. Here they sprout and become established and continue to grow, gradually enlarging the group, but never spoiling the symmetry.

The trees occupying these upper reaches are extremely hardy. They never grow to a large size, seldom becoming more than 50 or 60 feet tall even at the lower limits of their range, but are able to endure very adverse conditions. As elevation increases, the groups of trees diminish in both size and number until timber line is reached at about 6,700 feet. They are usually twisted and contorted, often forming prostrate mats. Occasionally we find a whitebark pine struggling for existence in the shallow soil at the edge of a rocky cliff or on a rocky ridge where it is continually being battered by strong winds or weighted down by heavy snow. Here at timber line the trees have made their last stand and beyond this, until we reach the limit of plant growth at the icy slopes of Mount Rainier, the vegetation is reduced to a few low plants which are able to produce flowers and fruits during the short summer season. An occasional alpine willow forms the only connection between the truly alpine upper regions and the dense forests below.

Douglas fir type.—The forests of Douglas fir (*Pseudotsuga taxifolia*) at Mount Rainier are among the most magnificent in the United States and have some of the largest trees in the Northwest. This species and western hemlock (*Tsuga heterophylla*) are the most common trees at the lower elevations in the park. Relatively large areas at the Longmire and Ohanapecosh entrances are covered with almost pure stands of Douglas fir but in the other regions in the park it is usually associated with other trees, particularly with western hemlock. Western red cedar (*Thuja plicata*) is also an important component of the forest at the lower elevations while, higher up, western white pine (*Pinus monticola*), silver fir (*Abies amabilis*), and noble fir (*Abies nobilis*) are associates. The forest floor is generally damp and cool with rather heavy duff. Common shrubs forming underbrush are vine maple (*Acer circinatum*), blue whortleberry (*Vaccinium ovalifolium*), red whortleberry (*Vaccinium parvifolium*), and salal (*Gaultheria shallon*). Young trees of western hemlock and western red cedar are also common.

Hemlock types.—Western hemlock (*Tsuga heterophylla*) is common in the valleys at the lower elevations, often in association with Douglas fir and silver fir. In the lower parts of the park, as along the Carbon River, there are especially fine stands of western hemlock mixed with Douglas fir and western red cedar.

Mountain hemlock (*Tsuga mertensiana*) occurs at higher elevations than the western hemlock. It is most conspicuous along with alpine fir on the higher slopes where the stands are open. These species, occasionally with Alaska cedar (*Chamaecyparis nootkatensis*), make up the forests in and immediately surrounding mountain parks as in upper Paradise Valley and similar locations.

Fir types.—The fir types, taken together, cover nearly twice as much area as any other timber type in the park. Silver fir (*Abies amabilis*) is the most abundant species and typically forms mixed or, less commonly, pure stands at middle elevations but ranges both lower and higher. In certain areas it is a common species in the understory of the Douglas fir and hemlock forests and may occur at higher elevations with mountain hemlock and alpine fir. The silver fir forests are usually quite dense with little undercover. Grand fir (*Abies grandis*) occasionally occurs along the White River and at other low elevations but is seldom noticed because of its close resemblance to silver fir. Noble fir (*Abies nobilis*) occurs most frequently as scattered groups of trees in the forests of middle elevations. The trees are outstanding wherever they occur because of their dense rounded crowns with a silvery tinge to the foliage and the large conspicuous cones. Alpine fir (*Abies lasiocarpa*) is one of the most common trees and the chief constituent of the forests at the higher elevations. It grows along with mountain hemlock in the high mountain meadows, forming tree islands in the so-called mixed or "mosaic" type. This is essentially a mountain-park type with islands of trees scattered here and there over a carpet of low green vegetation. Grand Park and Yakima Park are outstanding examples of these magnificent areas for which Mount Rainier National Park is so famous. There could scarcely be a more picturesque setting for Mount Rainier.

Cedar types.—Western red cedar (*Thuja plicata*) rarely, if ever, occurs as a dominant forest type, but is a common associate with Douglas fir and western hemlock in the lower portions of the park. Huge specimens are found, some of which approximate the Douglas fir in size.

Alaska cedar (*Chamaecyparis nootkatensis*) is found typically growing in association with alpine fir and other conifers at elevations above the western red cedar. In the upper part of its range it occasionally occurs in small pure stands. Although the Alaska and western red cedar resemble each other to a considerable extent, they are rarely confused because their ranges seldom overlap.

Spruce types.—Engelmann spruce (*Picea engelmannii*) occasionally occurs in small groups or as scattered trees in the northern parts of the park. The largest areas occur on the moraine near the end of Emmons Glacier and on Chenuis Ridge. Sitka spruce (*Picea sitchensis*) is represented by only a few specimens reported from the Puyallup watershed, the Mowich watershed, and from the vicinity of Carbon River.

Pine types.—Western white pine (*Pinus monticola*) is common in only a few localities in the park. It seldom occurs as a pure type except in old burned areas, such as along the Cowlitz River and Stevens Creek. It is associated with Douglas fir and, at higher elevations, with silver fir. This species occurs most commonly as scattered individuals in other types at middle elevations.

Whitebark pine (*Pinus albicaulis*) occurs in the subalpine forests with alpine fir and mountain hemlock where it favors the more exposed slopes and ridges. It becomes dwarfed and prostrate at timber line.

Woodland type.—Comparatively few broadleaf trees are found in the park and these do not occur in great abundance. Red alder (*Alnus oregona*) is the most common species along the lower streams. In a few localities, such as in Stevens Canyon, tree forms of willow occur, chief of which is Scouler willow (*Salix scouleriana*). Bigleaf maple (*Acer macrophyllum*) is a common broadleaf tree of the lower forests. Along the higher mountain streams mountain alder (*Alnus viridis* var. *sinuata*) is a common species, often forming almost impenetrable thickets 10 or 15 feet high. Such thickets are found at the head of Stevens Canyon on the south side of the park. Many shrub species of willow occur along the higher streams and on moist open slopes, often forming dense colonies.

Forests of Crater Lake National Park

Crater Lake, a marvelously blue body of water, situated on the crest of the lofty Cascade Range, is located in the heart of one of the most interesting mountainous forest regions of southern Oregon. Over all the region is spread a wonderful array of evergreen trees which closely clothe the slopes, surround the mountain meadows, and dot the canyons and the crater rim. The heavy forest mantle is second only to the lake in attractiveness. The character of the forest is mainly that of the higher mountains, but intermingling with it at the boundaries are often found species of the lower elevations. Within the confines of the park there are represented more than a dozen species of cone-bearing trees including pines, firs, and hemlocks, growing in pure or mixed stands. Relatively few broadleaf trees are represented and they are mostly small and shrubby, occurring as underbrush in open forests or forming thickets along streams.

Ponderosa pine type.—Ponderosa pine (*Pinus ponderosa*) typical of the Transition Zone, occurs in favorable warm locations up to an altitude of about 5,500 feet. The forests are composed largely of even-aged mature trees 100 to 150 feet in height and 30 to 40 inches in diameter. The species occurs in Crater Lake National Park in widely separated areas, in the northeast and the southeast corners. This tree is ordinarily seen by the park visitor along the south entrance road, where it is mixed with white fir and sugar pine. Pure stands and much larger types occur in the northeast corner. Here it is occasionally mixed with white fir and Shasta fir. The forest floor in this type is relatively clean of dead and down material, and, as a rule, the areas are open and parklike.

Lodgepole pine type.—Lodgepole pine (*Pinus contorta*) is quite generally distributed over the park except at the higher elevations. The flat-bottomed valleys radiating in all directions from the rim of the crater support pure or almost pure stands of lodgepole pine. The type is often characterized by much dead standing and down material for the tree is readily susceptible to insect damage and the shallow root system makes them easily uprooted. In many of these areas attacks by bark beetles have left as much as 50 percent of the stand dead. The accumulation of material on the forest floor and the large number of standing snags constitute a serious fire hazard. The fact that the lodgepole pine grows with a large number of stems per unit area only adds to this hazard. The average height of the trees is 60 feet with trunk diameters of 4 to 11 inches. Rarely one is found with a diameter of more than 20 inches.

The lodgepole pine forms mixed stands with many other tree species in the park, namely, mountain hemlock (*Tsuga mertensiana*), western white pine (*Pinus monticola*), and Shasta fir (*Abies magnifica* var. *shastensis*). Shrubs associated with the types are, in general, not abundant as to the number of species. One area of lodgepole pine is worthy of note because of the particularly fine western white pines which are associated with it. Many of the white pine trees are 130 feet tall with diameters of more than 36 inches. This stand occurs on the northeast slope of Grayback Ridge near the edge of Pinnacle Valley.

Fir type.—The fir type is composed chiefly of Shasta fir (*Abies magnifica* var. *shastensis*) with white fir (*Abies concolor*) and alpine fir (*Abies lasiocarpa*) (fig. 7) occurring to a much less extent. Shasta fir is itself one of the most common trees in the park, being found practically everywhere except at the lowest and highest elevations, but seldom in pure stands. Mountain hemlock is the most common associate. Shasta fir occurs most commonly on moist slopes or in cool canyons at elevations between 6,000 and 8,000 feet. An especially heavy growth may be seen on the north-facing slope of Bald Crater where it forms a pure stand. The trees in this area have their branches and trunks covered with a heavy growth of lichen and moss, and the forest floor is heavily covered with litter. Several shrubs commonly associated with the fir type are pine mat manzanita (*Arctostaphylos nevadensis*), green-leaf manzanita (*Arctostaphylos patula*), grouse whortleberry (*Vaccinium scoparium*), and big whortleberry (*Vaccinium membranaceum*).

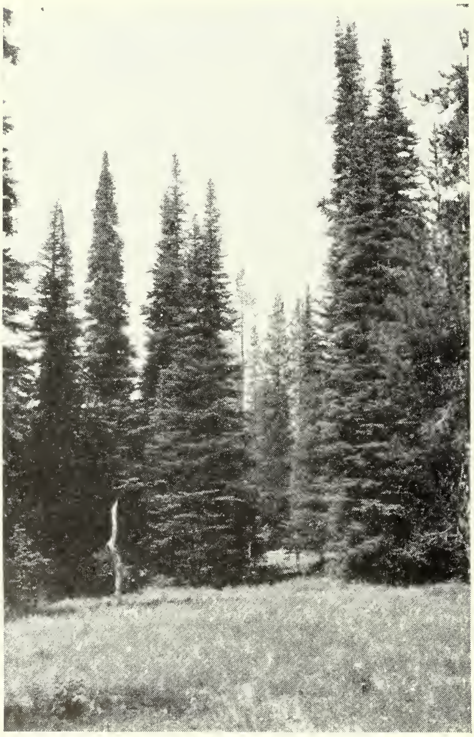

Figure 7.—Alpine fir. Crater Lake National Park.

Hemlock and whitebark pine types.—The mountain hemlock (*Tsuga mertensiana*) and whitebark pine (*Pinus albicaulis*) at Crater Lake occupy the highest life zone in the park. Unlike most of the Pacific Slope and Rocky Mountain parks, Crater Lake National Park has no subalpine type. The whitebark pine, even on the highest peaks, while not attaining any great size, is definitely not dwarfed or matted as it is in the case of the typical subalpine type.

The hemlock forest forms a band encircling the rim of the crater and extends for some distance below. This type is characterized by a rather sparse groundcover composed principally of Mazama currant (*Ribes erythrocarpum*), creeping blackberry (*Rubus lasiococcus*), and several herbaceous plants. On the highest peaks, including Mount Scott, Cloudcap, Bald

Crater, and Timber Crater, the hemlock is associated with whitebark pine. A small patch of this type occurs also on the inner wall of the crater.

Douglas fir type.—Douglas fir (*Pseudotsuga taxifolia*) occurs in a relatively few isolated areas, mainly on the west side of the park in canyons and on warm southwest-facing slopes. It is not found in pure stands and the areas occupied are not large. Its common associates are white fir, Shasta fir, and alpine fir.

Miscellaneous types.—A very small stand of Engelmann spruce (*Picea engelmannii*) occurs along lower Wheeler Creek at the Pinnacles near the east entrance. Here the trees grow in deeply cut, moist, and shady canyons. Examples of the woodland type in the park are few, but one small area containing aspen (*Populus tremuloides*) is found in cool canyons at the Pinnacles where the Engelmann spruce occurs. Just south of the old park boundary, on the Fort Klamath road, is located another small woodland area composed chiefly of black cottonwood (*Populus trichocarpa*) and incense cedar. Scatterings of aspen are found all along the south entrance road and in a few places on the west side of the park. Scattered trees of incense cedar (*Libocedrus decurrens*) are found here and there on the west side, but nowhere in abundance. Near Copeland Creek along the highway are several large specimens which may be seen from The Watchman on a clear day.

Forests of Lassen Volcanic National Park

Lassen Volcanic National Park, situated near the southern end of the Cascade Mountains, in northeastern California, includes within its area 163 square miles, three-fourths of which is forest covered. Visitors seldom take the time to consider the importance played by the forest cover of the park in relation to the enjoyment of the region. Besides contributing to the inherent beauty of the forest, the trees protect the watersheds and are, therefore, indirectly responsible for the many beautiful lakes and streams (fig. 8). The forests of the park are for the most part made up of high-altitude types. Lodgepole pine, Jeffrey pine, and red fir predominate in pure stands or in association with white fir or, occasionally, with western white pine. Magnificent mountain hemlock stands, typical of the Cascade forests to the north, are common. Jeffrey pine is the most common pine in the park and sugar pine one of the most rare. It is noteworthy that in a 15-minute stroll around Reflection Lake one may see specimens of all the species mentioned above.

Fir type.—This type is composed of red fir (*Abies magnifica*) and white fir (*Abies concolor*) in pure or mixed stands, the white fir occurring predominantly at the lower elevations and the red fir at higher elevations. The fir type composes approximately a fourth of the forested area of the park with red fir dominating in most of the area covered (fig. 9).

Pine types.—Lodgepole pine (*Pinus contorta*) is abundant in the park, occurring typically in pure stands. An especially large stand is found on the

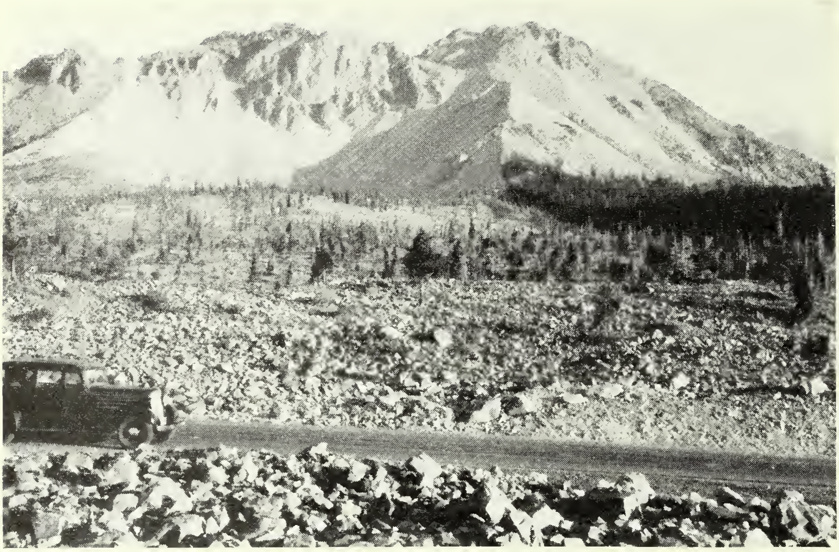

FIGURE 8.—Chaos Lava Beds, Lassen Volcanic National Park.

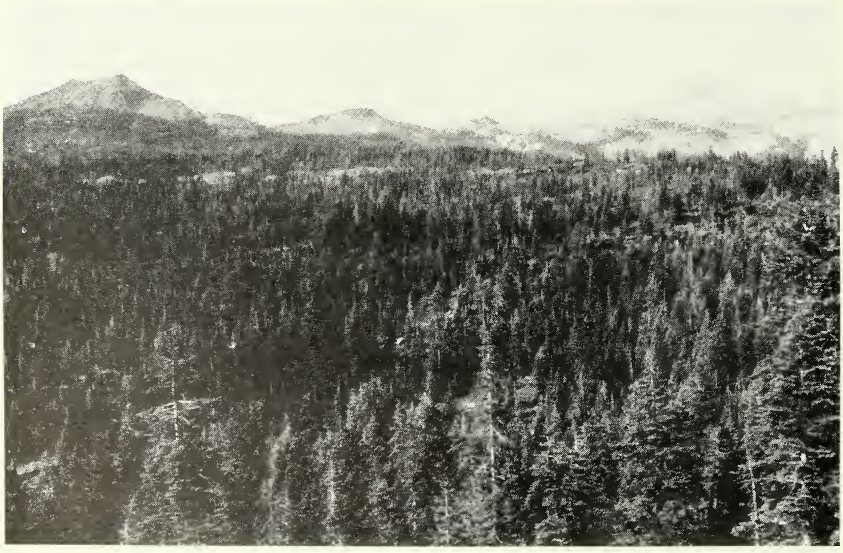

FIGURE 9.—A typical scene in a red fir-white fir-lodgepole pine forest. Lassen Volcanic National Park.

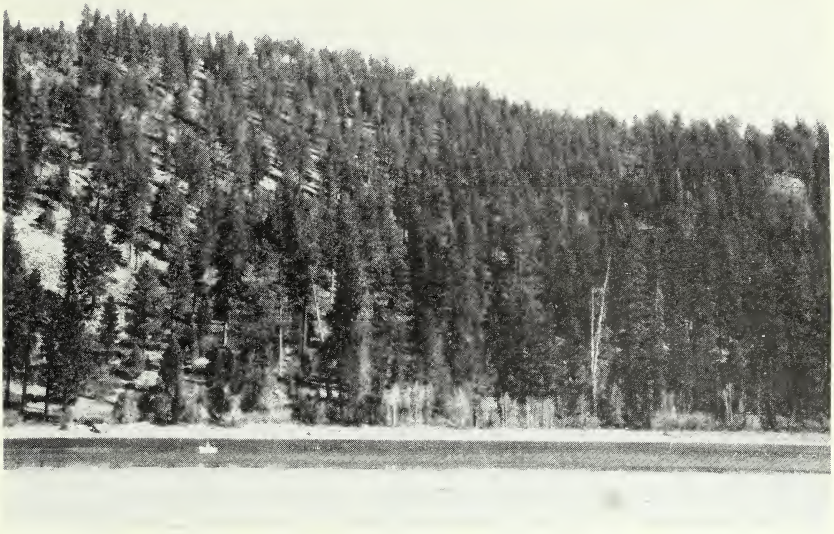

Figure 10.—Jeffrey pine type. Lassen Volcanic National Park.

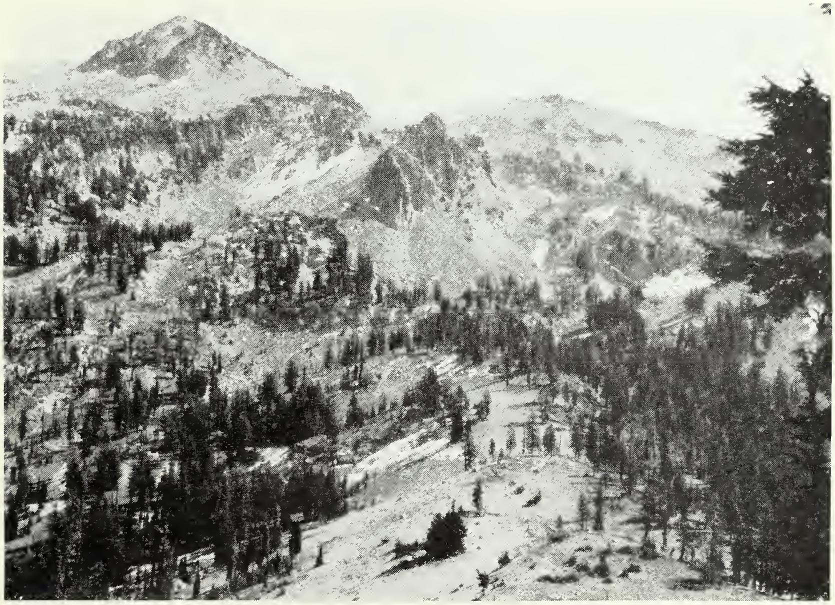

Figure 11.—Mountain hemlock-red fir forest. Lassen Volcanic National Park.

eastern side of the park between Juniper Lake and Snag Lake, and in the northern part of the park along Hat Creek Drainage and on the west side of Cinder Cone.

Jeffrey pine (*Pinus jeffreyi*) (fig. 10), the most abundant pine in the park, is common near the northern boundary and in the southeast portion of the park where it often forms beautiful, open, parklike stands of nearly pure Jeffrey pine. It occurs most commonly, however, in association with red or white fir. Approximately three-fifths of the area covered by Jeffrey pine is in association with fir.

Five-needle pine types.—Sugar pine (*Pinus lambertiana*) is for the most part outside of its range in Lassen Volcanic National Park but enters in the southeastern part and in the southwestern extension where it is mixed with Jeffrey pine and white or red fir. Western white pine (*Pinus monticola*), usually in association with red fir, is more prevalent than sugar pine. It is common in the vicinity of Echo Lake and Hat Mountain. Whitebark pine (*Pinus albicaulis*) occurs in a few small areas on the ridges and semi-barren windswept sides of Lassen Peak up to the limit of tree growth.

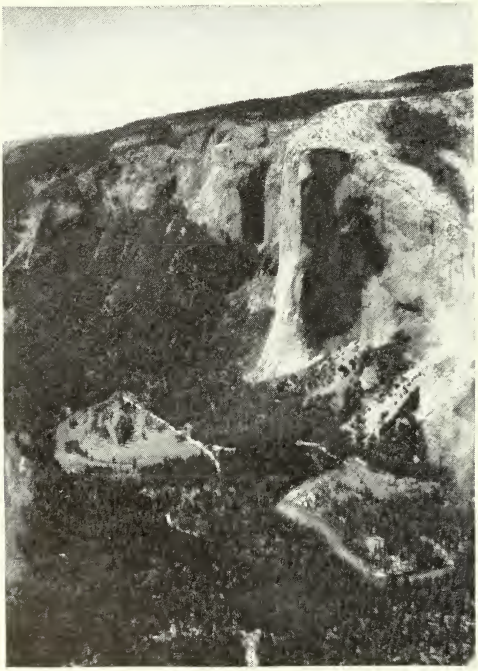

Figure 12.—The floor of Yosemite Valley is covered predominantly with ponderosa pine. The forest in the background and showing near the horizon is composed primarily of red fir and white fir, and on top of El Capitan semibarren Jeffrey pine forest occurs.

Mountain hemlock type.—Mountain hemlock (*Tsuga mertensiana*) is abundant in the southwestern portion of the park where it occurs in pure stands or in association with red fir. It is also common on the ridges surrounding Lassen Peak (fig. 11). The loop highway between Manzanita Lake and the summit of the divide passes through an unusually fine stand of pure mountain hemlock. The nodding tops all seem to bend in one direction, hence it is sometimes referred to as the compass tree. John Muir, in his writings, refers especially to the magnificent stands of hemlock found in the park.

Woodland type.—The woodland type of the park does not cover any large areas. It is made up predominantly of aspen (*Populus tremuloides*) and willow. Mountain alder (*Alnus tenuifolia*) and black cottonwood (*Populus trichocarpa*) occasionally occur in the type.

Forests of Yosemite National Park

The forests of Yosemite National Park[3] (fig. 12) are divided into definite belts or zones as evidenced by the differences in species associations at the various altitudes. It is interesting to note the regularity with which the various types appear at certain altitudes as one passes from the foothills west of the park to the snowcapped peaks of its eastern boundary. Species succeeds species in orderly procession and one can tell the approximate altitude by the kind of trees found, or vice versa, if he knows the approximate altitude of his locality, he can tell what species of trees to look for. Driving from the San Joaquin Valley towards the west entrance of the park, one passes through the Lower Sonoran Zone, a nearly treeless lower foothill region which does not extend into the park. Further along, in the upper foothills and lower mountain ranges between 1,000 and 3,000 feet elevation, digger pine makes its appearance in the Upper Sonoran Zone. This is the first cone-bearing tree to be seen. Associated with it are blue oak, valley oak, highland live oak, California buckeye, manzanita, wedgeleaf ceanothus and, less commonly, mountain mahogany. The digger pine type extends up the Tuolumne River as far as Tiltill Valley.

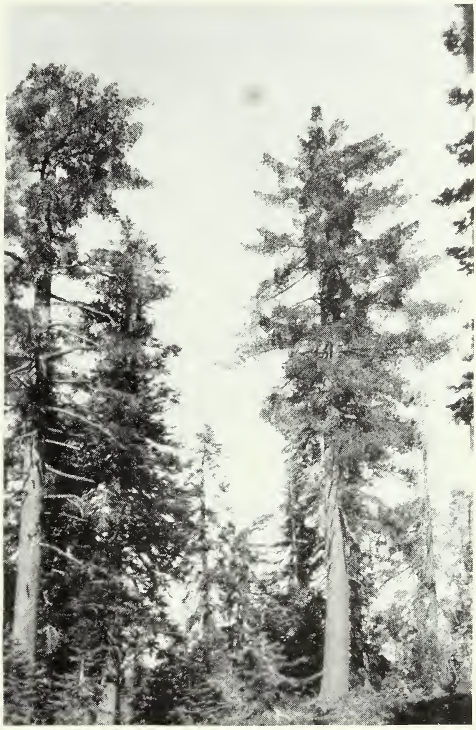

FIGURE 13.—Sugar pine. Yosemite National Park.

Between 3,000 and 4,000 feet elevation the tree life changes noticeably as the great forest belt of the Transition Zone really begins, extending up to 6,500 or 7,000 feet elevation. This zone includes the Yosemite Valley where Douglas fir, incense cedar, white fir, ponderosa pine, California black oak, and canyon live oak occur in abundance. It is also the region of the majestic sugar pine and the giant Sequoia or Big Tree. Along the streams are found black cottonwood, white alder, Pacific dogwood, creek dogwood, and willows. Lodgepole pine, which is typical of the higher altitudes, occasionally comes down into this belt on the cool, north-facing slopes. A few scattered specimens of bitter cherry and western chokecherry grow in this region while dwarf maple occurs sparingly in the upper limits.

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[3] Hudson, J. P. Zonal distribution of trees in Yosemite National Park, Manuscript, 1933.

Near 7,000 feet elevation another decided change takes place as we go into the Canadian Zone. The ponderosa pine is replaced by Jeffrey pine, canyon live oak is replaced by huckleberry oak (a shrub), black cottonwood by quaking aspen, and many of the other broadleaf trees and shrubs disappear. These changes are very noticeable on a trip from the floor of Yosemite Valley (4,000 feet) to Glacier Point (7,200 feet) where Jeffrey pine and lodgepole pine predominate as forest trees in association with red fir, western white pine, and western juniper. White fir, sugar pine, and Douglas fir may still be found but not in such abundance as at lower elevations.

The last zone of trees, and the most picturesque portion of the park, in the opinion of many visitors, is the subalpine belt from about 9,000 feet up to timber line at 11,000 feet. This is known as the Hudsonian Zone. Lodgepole pine and western juniper are the dominant trees with whitebark pine and mountain hemlock becoming prominent in the upper part of the belt. These latter are the most common timber line trees. Above this the soil is usually limited in quantity and confined to the crevices between the jagged blocks of granite.

The Arctic-Alpine Zone extends from timber line to the crest of the Sierras which forms the eastern boundary of the park. No trees grow in this barren, rocky area, and only a few prostrate shrubs, such as the alpine willows, can survive the severe conditions. However, a large number of the smaller, often rare, flowering plants grow here, bloom, and produce seed during the short period of spring and summer.

Ponderosa pine type and Jeffrey pine type.—The lower and middle elevations on the west side of the park lie within the yellow pine belt which stretches along the western slope of the Sierra Nevada. Ponderosa pine (*Pinus ponderosa*) is the common dominant in these forests. In pure stands, the type has very low or scarcely any shrubby undercover. Under favorable circumstances the trees may attain 5 or 6 feet in diameter. Jeffrey pine (*Pinus jeffreyi*) occupies the higher south-facing slopes and semibarren ridges, commonly between 6,000 and 9,000 feet elevation. Where both species occur in mixed stands they are so similar in appearance that it requires some experience before one can distinguish between them. The common tree associates of ponderosa pine are sugar pine (*Pinus lambertiana*) white fir (*Abies concolor*), and black oak (*Quercus kelloggi*); those of Jeffrey pine are red fir (*Abies magnifica*) and canyon live oak (*Quercus chrysolepis*). Where the two pines occur together, the associates of either may be present. In open stands Jeffrey pine often has a shrubby undercover of green leaf manzanita (*Arctostaphylos patula*) or on semibarren sites, huckleberry oak (*Quercus vaccinifolia*) and western juniper (*Juniperus occidentalis*).

Sugar pine type.—Sugar pine (*Pinus lambertiana*) (fig. 13) occurs typically in mixed stands. It is most common as an associate in other types, particularly in the ponderosa pine type, Jeffrey pine type, and the fir types, ranging between 4,000 and 7,500 feet elevation. The finest stands are found along the western boundary in the vicinity of the Tuolumne Big Tree grove and at Carl Inn. Some of the larger trees attain a diameter of 5 to 7 feet and a few as much as 8 to 10 feet.

Whitebark pine type.—Whitebark pine (*Pinus albicaulis*) is usually found in pure stands forming a belt of its own at and just below timber line. Here much of the region has been scoured to bedrock by glaciers and is devoid of soil except for that lodged in rock crevices. A bird's-eye view of the country north of Hetch Hetchy Valley presents an aspect of stringers of trees interspersed with areas of totally bare, gray-white granite. The trees are generally small in stature often with gnarled or twisted branches, and may form low mats not more than a few feet high on the wind-swept ridges at timber line, sometimes covering areas of 75 to 100 square feet. It is typically a small tree and under the best conditions seldom reaches more than 30 feet in height or 2 feet in diameter. Below timber line whitebark pine often occurs in association with lodgepole pine and mountain hemlock.

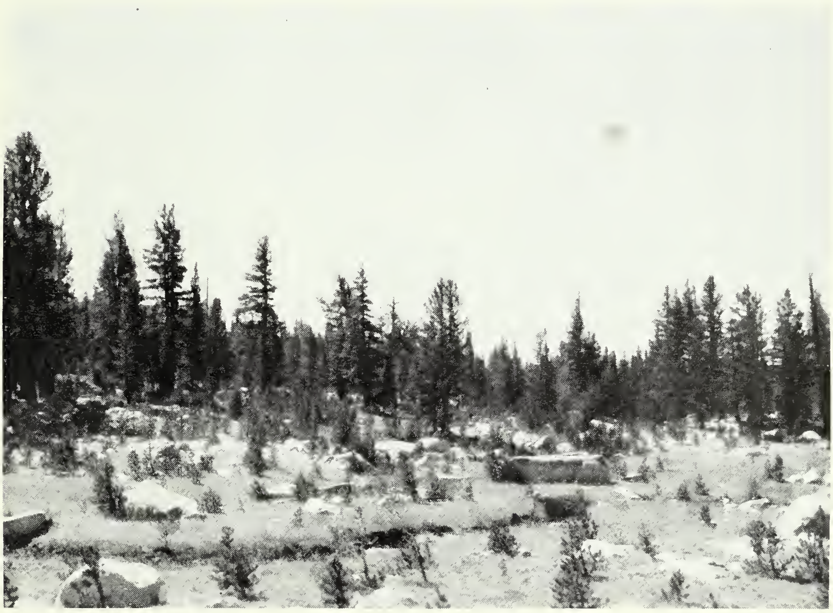

FIGURE 14.—Lodgepole pine and meadow. Yosemite National Park.

Lodgepole pine type.—Much of the eastern part of the park between 7,000 and 10,000 feet elevation is covered with forests of lodgepole pine (*Pinus contorta*) (fig. 14) which occur in pure stands or mixed with mountain hemlock (*Tsuga mertensiana*), western white pine (*Pinus monticola*), or whitebark pine (*Pinus albicaulis*). The stands are often dense with little or no undercover and the trees in such instances seldom attain more than 6 inches in diameter. In open stands the trees grow much larger, and around mountain meadows and lakes it is not uncommon for them to reach 2 or 3 feet in diameter. Scattered specimens of lodgepole pine occur as low as 4,000 feet and from there on up to timberline.

Mountain hemlock type (fig. 15).—Mountain hemlock, though not nearly so abundant as lodgepole pine, forms sizeable stands and is frequently associated with it. The tree develops to largest size in sheltered spots just below timber line and may attain a diameter of 3 feet or more under favorable conditions. Between 7,500 and 10,500 feet elevation it occurs in pure stands or mixed with lodgepole pine and western white pine. On semibarren sites near timber line whitebark pine and Sierra Juniper are common associates. Wherever it occurs it can easily be distinguished by its nodding top and drooping, densely foliaged branches.

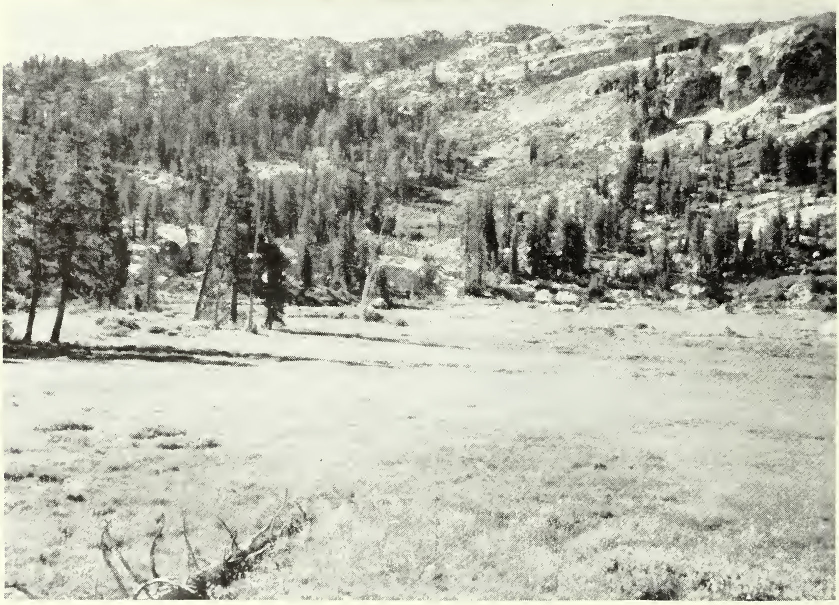

Figure 15.—Smedberg meadow with mountain hemlock in the background. Such scenes are typical at high elevation in Yosemite National Park.

Western white pine type.—This type and that of mountain hemlock are found over approximately the same elevational range and cover an area of about equal size. Red fir, lodgepole pine, and mountain hemlock are the most common associates. At middle elevations the western white pine attains considerable size, the trees sometimes reaching a diameter of 5 to 6 feet. At the higher elevations it grows only in sheltered places as a small but erect tree.

Fir types.—Two species of fir, white fir (*Abies concolor*) and red fir (*Abies magnifica*) are found in the park and these make up the fir type which covers about a fifth of the forested area of the park. White fir is seldom found in pure stands but is associated with such trees as ponderosa pine or sugar pine. The trees attain fair size, becoming 150 feet high with trunks 3 to 4 feet in diameter, but this size is generally exceeded by the pines associated with it. Red fir sometimes occurs with the white fir but ordinarily ranges above it in pure stands or associated with Jeffrey pine, western white pine, or lodgepole pine. The variety, Shasta fir (*Abies magnifica shastensis*) also occurs in the park but apparently is not common.

Douglas fir type.—Douglas fir (*Pseudotsuga taxifolia*) is confined to relatively small areas in the park, principally in the Hetch Hetchy and Yosemite Valleys. It occurs chiefly on semibarren canyon walls in association with canyon live oak, huckleberry oak, or on better sites, with black oak. The tree is of particular interest in the park because it is near the southern limit of the species in the Sierra Nevada.

Woodland type.—Woodland occurs in the lower foothills and along the streams in the Hetch Hetchy, Yosemite, and Wawona Valleys. The principal species making up the type are highland live oak (*Quercus wislizenii*), canyon live oak (*Quercus chrysolepis*), black oak (*Quercus kelloggii*), and occasionally aspen (*Populus tremuloides*), black cottonwood (*Populus trichocarpa*), and willows. Scattered trees of digger pine occur in the type at lower elevations. It reaches a larger size than most of the broadleaf trees, becoming 3 feet in diameter and 70 feet in height. While the pine is not common in the park it attains considerable prominence at the mouth of Hetch Hetchy Canyon. The tall pines make a strange contrast to the low chaparral and oaks with which they are associated.

Big Tree type.—Big Tree (*Sequoia gigantea*) occurs in three groves in the park—the Mariposa Grove, the Merced Grove, and the Tuolumne Grove. Big Tree does not occur in pure stands but is found associated with sugar pine, ponderosa pine, Jeffrey pine, white fir, red fir, or incense cedar. The Mariposa Grove is the largest of these groves, and contains the Grizzly Giant, the largest Big Tree in the park. It is 209 feet tall, and measures 34.7 feet in diameter at its greatest basal diameter. In this grove, also, is the famous Wawona tree with a tunnel through which one may drive.

Forests of General Grant National Park[4]

General Grant National Park, an area of only 2,507 acres northwest of Sequoia National Park, was created to preserve 140 acres of Big Trees, including the General Grant Tree for which the park was named. This tree, in the Grant Grove, is 267 feet high and its greatest basal diameter is 40.3 feet. It has been dedicated as the Nation's Christmas tree and each year is the scene of devotional services at noon on Christmas day. A second Big Tree grove is located in the northwest section of the park and a few trees occur also along Sequoia Creek in the southwest part. Sugar pine (*Pinus lambertiana*) and white fir (*Abies concolor*) are the common associates in the Big Tree type. Ponderosa pine (*Pinus ponderosa*) and incense cedar (*Libocedrus decurrens*) also occur.

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[4] By Act of Congress March 5, 1940, this area was designated as the General Grant Grove Section of Kings Canyon National Park.

The pine-fir type is the most common type in the park, occupying most of the area outside of the Big Tree type. White fir and sugar pine, the dominant species in this type, are found over most of the park. The Generals Highway passes through this type. The fir type, occurring chiefly in the northeast section of the park, is composed principally of white fir and Shasta fir (*Abies magnifica* var. *shastensis*). Bitter cherry (*Prunus emarginata*) and whitethorn (*Ceanothus cordulatus*) are common shrub associates. The pine type is composed chiefly of ponderosa pine and sugar pine and, less commonly, Jeffrey pine (*Pinus jeffreyi*). This type predominates on the west side of the park along the Sequoia Lake road. Common shrubby associates are deerbrush (*Ceanothus integerrimus*) and mountain misery (*Chamaebatia foliolosa*). A small area of Jeffrey pine and sugar pine occurs in the vicinity of Sunset Rock in association with green leaf manzanita (*Arctostaphylos patula*). The woodland type is limited to a small patch of aspen (*Populus tremuloides*) in the northeast corner of the park.

Forests of Sequoia National Park

Sequoia National Park was created and named for the Big Tree (*Sequoia gigantea*) of which there are 30 groves in the park. The finest specimens of Big Tree are found at Giant Forest, the largest grove. Muir relates after his first visit to this area: "I entered the sublime wilderness of the Kaweah Basin. This part of the Sequoia belt seemed to me the finest and I then named it 'The Giant forest.' It stands, a magnificent growth of giants grouped in pure temple groves, arranged in colonnades along the sides of the meadows or scattered among the other trees."

Sequoia National Park may be divided into two sections according to the types of vegetation. The forests on the west side of the park where the Big Tree occurs are quite different from those of Kern Canyon and its tributaries on the east. On the west the principal species are white fir, ponderosa pine, sugar pine, and incense cedar, with Shasta fir, Jeffrey pine. lodgepole pine, and western white pine ranging at higher elevations. In the Kern River drainage foxtail pine and lodgepole pine predominate with white fir and Jeffrey pine in only the bottoms of the canyons and on the slopes at the lower southern end. Here also may be found a few incense cedars and sugar pines. The flora of the Kern Canyon is unique in that it contains a number of plants which are found here and nowhere else in the park. A conspicuous example of a narrowly distributed plant is *Ceanothus pinetorum*, a common shrub of the region, with spine-toothed leaves and blue flowers.

Big Tree type.—Big Tree (*Sequoia gigantea*) is not found in pure stands but in association with sugar pine (*Pinus lambertiana*) and white fir (*Abies concolor*) or other conifers. Sugar pine, white fir, ponderosa pine, Shasta fir, and incense cedar are all present at Giant Forest. The type is found for the most part between 6,000 and 7,500 feet elevation, but scattered trees occur as high as 8,000 feet and as low as 5,500 feet. The highest known location for a Big Tree is above Atwell Mill on the southeast slope of Paradise Ridge where an isolated tree has been found which is 140 feet high with a trunk 13½ feet in diameter. The lowest known Sequoia in the park is located just below Clough Cave at 3,500 feet elevation, although another tree occurs at 3,000 feet outside of the park boundary. The four largest groves in the park are Garfield Grove, Atwell Mill Grove, Dillon Wood Grove, and Giant Forest Grove. Thousands of trees more than 10 feet in diameter occur in the park and the largest Big Trees attain 30 to 35 feet in diameter. The undergrowth in these forests is scant and the forest floor, often deeply covered with litter.

At Atwell Mill where openings in the Big Tree forest occur due to past logging operations, a vigorous growth of saplings seems to discredit the statement that the Sequoia is a dying race. One feels reassured that people for generations to come will have an opportunity to visit Big Tree groves.

Ponderosa pine type.—Jeffrey pine type.—A large part of the total forested area of the park is composed of pure pine types, including ponderosa pine (*Pinus ponderosa*) and Jeffrey pine (*Pinus jeffreyi*). The ponderosa pine is usually found on more fertile slopes and at lower elevations than is the Jeffrey pine which predominates on the semi-barren areas at higher elevations. However, the two species may form mixed stands. In open stands of Jeffrey pine there is frequently an undercover of such shrubs, as greenleaf manzanita (*Arctostaphylos patula*) and Sierra chinquapin (*Castanopsis sempervirens*). The ponderosa pine forests are usually open, often with a shrubby under-story consisting of such shrubs as bearmat (*Chamaebatia foliolosa*) or with only a cover of pine needles. Ponderosa pine is rare in the Kern Canyon region but here Jeffrey pine is abundant on the canyon walls and on the plateau back of the rim.

Sugar pine type.—Sugar pine (*Pinus lambertiana*) occurs only in mixed stands with other species of pine and fir. It is particularly common in the ponderosa pine type, the Jeffrey pine type, the white fir type, and the Shasta fir type. The finest stands in the park occur in the vicinity of Giant Forest in the Big Tree groves. The trees are rare on the east side of the park in the Kern drainage.

Western white pine type.—Occupying about the same vertical range as does Shasta fir (7,500 to 10,500 feet elevation), it rarely is found in pure stands but commonly is associated with other conifers, especially Shasta fir, and in the Kern with foxtail pine. Like the foxtail pine it grows erect even at the higher elevations near timber line. Here, however, it grows only in the sheltered spots seemingly unable to endure the rigorous climatic conditions found on the wind-swept ridges at tree line.

Lodgepole pine type.—Lodgepole pine (*Pinus contorta*) is commonly found at middle and high elevations in the park. The type is particularly abundant in the vicinity of Hockett meadow, on the Chagoopa plateau, and in the Kern Canyon and tributary canyons. Near timber line on either side of the Great Western Divide one often comes upon patches of this type surrounding meadows or lakes. The trees frequently attain diameters of 2 to 4 feet, appearing quite different from the smaller lodgepole pines found in the Rocky Mountains, and some botanists consider them as a variety or subspecies. The trees commonly occur in pure stands or mixed with foxtail pine, western white pine, or red fir.

Foxtail pine type.—Foxtail pine forms extensive stands in the high plateau country on the east side of the park. Here it occurs most commonly as pure stands but also is found mixed with lodgepole pine, Shasta fir, western white pine, or white bark pine. In the Kern country one can walk for miles through foxtail pine forests, but on the west side of the Great Western Divide the trees occur only in scattered stands. Shrubby and herbaceous ground cover is frequently lacking on the semibarren sites and the trees seldom attain more than 50 feet in height or 3 feet in diameter. They retain an erect posture even at timber line which makes them easily distinguished from the associated whitebark pine.

Miscellaneous pine types.—Singleleaf piñon (*Pinus monophylla*) is found sparingly on the walls of the Kern Canyon between Laurel Creek and a point just above Rock Creek. The trees occur widely scattered and may be distinguished from other pines by the gnarled twisted branches. It is seldom seen by the park visitors and because of its rarity is of unique interest.

Limber pine (*Pinus flexilis*) is found in a small stand at the mouth of Whitney Creek in the Kern drainage and again on the edge of Chagoopa Plateau where only one individual was found. In the former stand lodgepole pine is the associate.

Fir types.—White fir (*Abies concolor*) and Shasta fir (*Abies magnifica* var. *shastensis*) cover large areas on the west side of the Great Western Divide but are not abundant in the Kern drainage. Shasta fir often forms pure stands while white fir occurs typically in mixed stands with sugar pine, ponderosa pine, Jeffrey pine, or red fir. Common associates of Shasta fir are Jeffrey pine, western white pine, lodgepole pine, foxtail pine, and white fir. The two firs also occur in mixed stands together, but the Shasta fir ordinarily ranges above the white fir and is more common. The forest floor under the fir forest is usually devoid of large undershrubs.

Western juniper type.—Western juniper (*Juniperus occidentalis*) is common on semibarren rocky canyon walls, particularly in the Kern drainage.

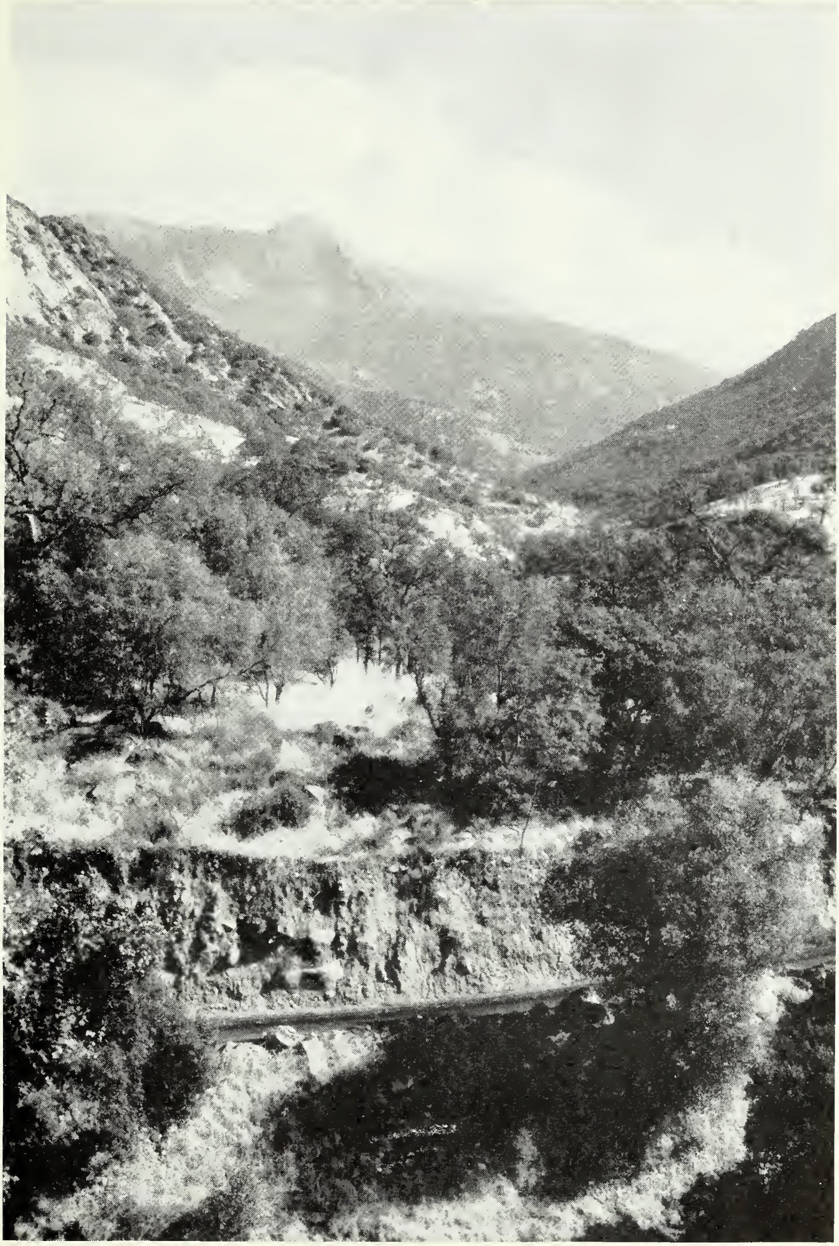

Figure 16.—A typical woodland-grass area in Sequoia National Park.

Here it occurs in open stands or as widely scattered individuals often in association with curl-leaf mountain mahogany. The trees are invariably dwarfed and distorted by heavy winds and snows.

Woodland type (fig. 16).—This type includes the common broadleaf trees in the park. Along the streams are found California sycamore (*Platanus racemosa*), white alder (*Alnus rhombifolia*), black cottonwood (*Populus trichocarpa*), and bigleaf maple (*Acer macrophyllum*), while black oak (*Quercus kelloggii*), highland live oak (*Quercus wislizenii*) and canyon live oak (*Quercus chrysolepis*) are the common trees on the drier slopes. Canyon live oak is the predominant species on the steep, rocky slopes and canyon sides just below the coniferous forest. Black oak occupies the better localities and is also often associated with ponderosa pine.

Forests of Glacier National Park

Glacier National Park is located in the Rocky Mountains in northwestern Montana. It is one of the most interesting of the parks from a botanical standpoint, for on the western side of the Continental Divide a forest predominates which has many plants characteristic of the Pacific Northwest, while on the eastern slope the forest is more characteristic of the Rocky Mountains. In the west-side valleys larch and lodgepole pine, white pine, and Douglas fir are characteristic, with lowland white fir, western red cedar and western hemlock occurring in some localities. Along the North Fork of the Flathead River are found a few stands of ponderosa pine. In the valleys on the east side of the Divide may be found dense stands of Engelmann spruce, alpine fir, and lodgepole pine. Above timber line only the hardiest shrubs and herbs occur. These include such plants as alpine willows, mountain dryad, mosses, lichens, and sedges. Lower stretches of these upper regions are covered with clumps of stunted alpine fir. The Continental Divide has constituted a barrier over which many plants could not cross and hence is responsible, in many instances, for their limit of distribution.

Alpine fir type.—Alpine fir (*Abies lasiocarpa*) is one of the most abundant and widespread tree species in the park. It ranges from the lower parts of the park to timber line on the higher mountains. The area covered is surpassed only by the lodgepole pine type which differs essentially from alpine fir in being predominantly a lower elevation type. Pure stands of fir frequently occur on the east side of the park, especially towards the upper ends of the canyons.

The fir forests are often characterized by a heavy undergrowth of chaparral or herbaceous species (fig. 17). The sites occupied at middle elevations are usually damp and cool, often with an understory of alder and menziesia. This is especially true along the creek bottoms, while at somewhat higher elevations, beargrass and other herbaceous plants may predominate with species of whortleberry (*Vaccinium*) common in many places.

In the upper regions the forests become open and parklike, the common ground-cover species being beargrass, species of rush (*Juncus*) and whortleberry.

Larch types.—There are two species of larch found in the park. Western larch (*Larix occidentalis*) occurs at the lower elevations, chiefly on the west side of the Continental Divide, while alpine larch (*Larix lyallii*) is found on both sides at high elevations near timber line. Western larch is most abundant in the low rolling country on the west side of the park. Fine stands occur at Lake McDonald and all along the Middle Fork of the Flathead River, extending back along the sides of the mountains into the heads of the side canyons. This larch is also quite abundant over much of the southern part of the park, occurring especially in mixtures with Douglas fir and lodgepole pine. In some sections, such as in lower Ole Creek, it covers considerable areas in association with willow or with willow and lodgepole. In recent burns larch reproduces readily, the young trees forming dense pure stands or, as is frequently the case, mixed with lodgepole pine.

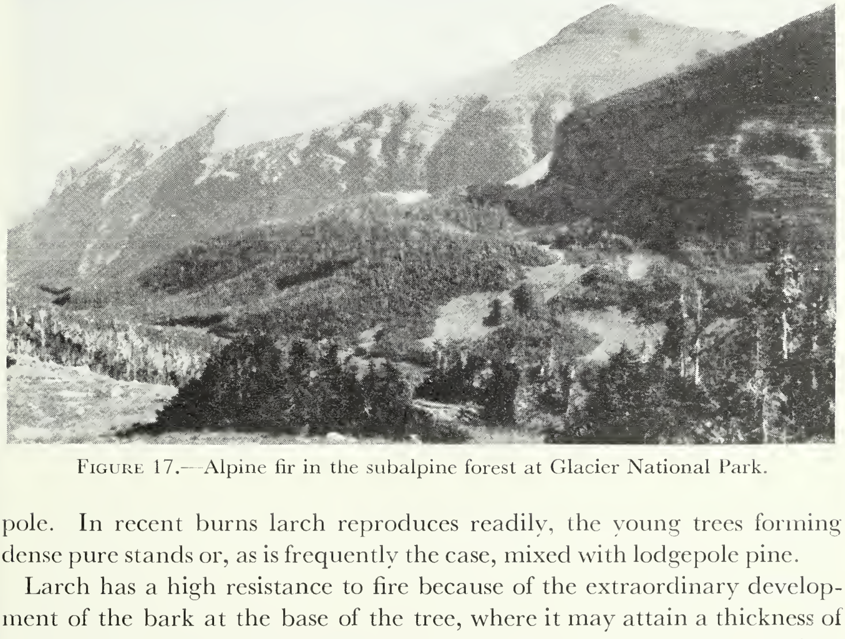

FIGURE 17.—Alpine fir in the subalpine forest at Glacier National Park.

Larch has a high resistance to fire because of the extraordinary development of the bark at the base of the tree, where it may attain a thickness of several inches. The trees which have survived the burn between Belton and Lake McDonald are predominantly western larch. Although rare on the east side of the Continental Divide, small patches of this larch are occasionally found there. One such patch is located at the south end of Waterton Lake, another at the mouth of Roes Creek. Three small and widely separated trees were found in Cut Bank Valley.

Alpine larch (*Larix lyallii*) (fig. 18) is found on both the east and west sides of the Continental Divide at high elevations near timber line, but is much less common than the western larch. The larch forest covers some 40,000 acres, only 1,100 acres of which are made up of alpine larch. This species is quite common in the high cirques at and a little below timber line on both sides of the Continental Divide. A fine stand is located in a cirque about 2 miles west of the south end of Waterton Lake and another in Paradise Valley east of Two Medicine Pass. Another stand of considerable size occurs on the west slope of Summit Mountain ridge. The alpine larch forests are usually open and parklike, often with a grass-herbaceous ground cover. The tree resembles western larch to a certain extent, but is much smaller and has a more rounded crown with fewer and more delicate needles. This species is apparently better able to withstand the rigors of the severe subalpine climate than are some of its associates at that elevation. Alpine larch of tree size will often be found while alpine fir growing near will be dwarfed and matted.

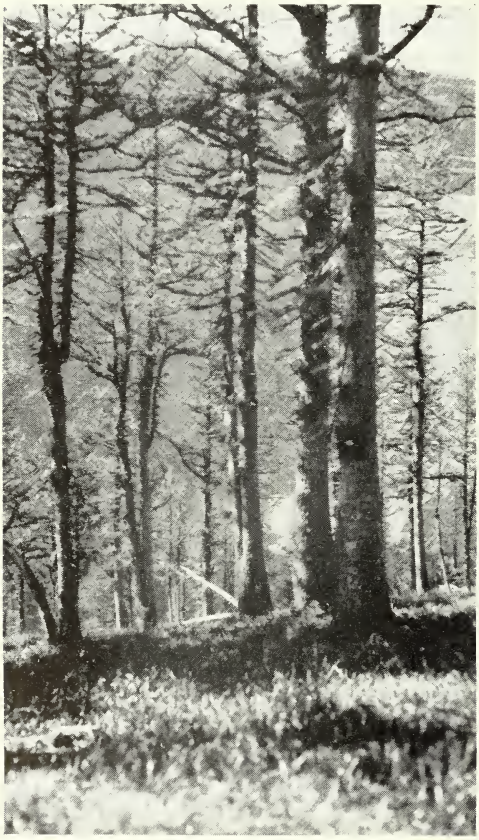

Figure 18.—Alpine larch. Glacier National Park.

Pine types.—Western white pine (*Pinus monticola*) is another tree which is rare on the east side of the Divide. It becomes the largest and most attractive pine on the west side of the park where it is scattered over considerable territory at low and middle elevations. Mature trees are rather uncommon except in one or two places, but the white pine reproduction has been found in many places.

Ponderosa pine (*Pinus ponderosa*) is found only in a few localities on the western side of the park. There are a few scattered trees around Belton and a few small groves in the North Fork Flathead River country between Camas Creek and Bowman Creek. This pine is much more common outside and beyond the park boundaries on the west side where it forms extensive parklike stands.

Lodgepole pine type. (fig. 19).—Lodgepole pine (*Pinus contorta*) occupies the largest total area of any vegetation type in the park. It covers some 179,466 acres, most of which is composed of pure lodgepole stands. It is the most common tree over most of the park except at high elevations and in deep cool canyons and is especially abundant in old burns due to its seed habits and its ability to reproduce quickly after a fire. Some of these stands are so dense with a growth of young trees or with a ground cover of fallen material that they are practically impenetrable. The large amount of highly inflammable debris and the density of the stands often form a serious fire hazard.

The tree is most common in the flat and rolling country and covers much of the North Fork section. Mixed stands of lodgepole pine with western larch, alpine fir, Engelmann spruce or Douglas fir are common. Beargrass and whortleberry are characteristic undercover species in these stands.

Timber-line pine type.—Whitebark pine (*Pinus albicaulis*) and limber pine (*Pinus flexilis*) (fig. 20) cover about 31,000 acres, much of which is semibarren. Apparently whitebark pine occurs primarily on the west side of the park while limber pine is common on the east side. Both species occur typically at high elevations, but occasional specimens come down quite low in places, especially on the east side where limber pine frequently occurs in the fir types at the lower elevations. Although limber pine has been recorded from the west side of the park, its abundance is uncertain because of the difficulty in distinguishing between it and whitebark pine. Cones are necessary to differentiate between the species and at such high altitudes they seldom develop. The cones of whitebark pine are even more rare than those of limber pine, due in part, probably, to the activity of birds and squirrels which are fond of the large pine nuts. Only a few specimens of whitebark pine were definitely located on the east side of the park, one along the upper part of the Grinnell Glacier trail and one in the canyon east of Amphitheatre Mountain. Trees in or near the subalpine regions

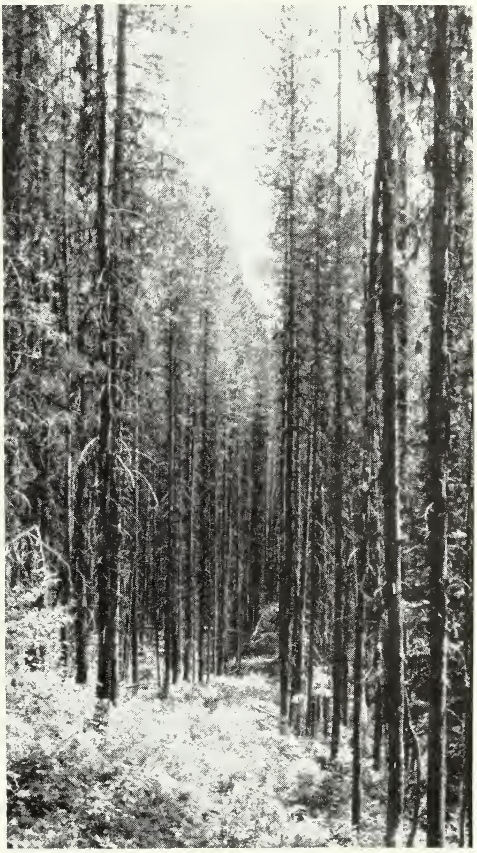

Figure 19.—Lodgepole pine, 5,200 feet elevation. Glacier National Park.

are usually dwarfed or matted. They seldom exceed a few inches in diameter. In the lower parts of the range large stands of fairly good-sized trees with large rounded crowns occur.

Western hemlock type.—Western hemlock (*Tsuga heterophylla*) and western red cedar (*Thuja plicata*), with which it is constantly associated, are typical representatives of the northwestern Pacific slope. Like the western white pine, they are not found in the other Rocky Mountain parks. At Glacier National Park they occur most abundantly around Lake McDonald, Upper McDonald Creek, and at the mouth of Avalanche Creek. The western red cedar grows to especially large size and probably includes some of the oldest trees in the park. Western hemlock is also long-lived and grows to good size, though not so large as the cedar.

Engelmann spruce type.—Engelmann spruce (*Picea engelmanii*) and alpine fir (*Abies lasiocarpa*) are the chief constituents of the spruce type in the park, covering nearly 70,000 acres. In this large area less than 10 percent is pure spruce. The tree prefers moist sites and so is the dominant species in canyon bottoms where the type is usually very uniform. The crown canopy of the spruce forest is characteristically dense and of a dark green color. A luxuriant growth of alder, thimbleberry, menziesia, whortleberry, and devilsclub forms the characteristic undercover.

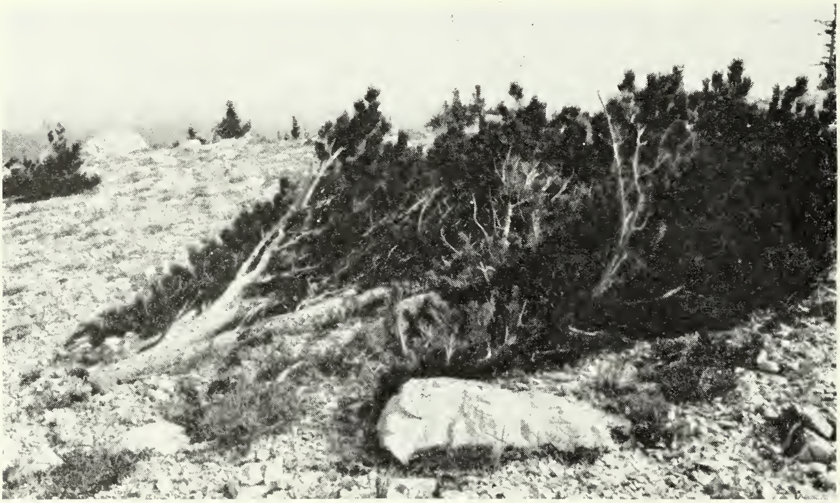

Figure 20.—Limber pine. Glacier National Park.

Splendid stands of Engelmann spruce may be seen along the edge of the Flathead River along with balsam poplar. It is also common on the mountain sides and occasionally enters into timber-line types, often taking a typical matted subalpine form (fig. 21). Along upper McDonald Creek there are some fine stands ascending well up the sides of the mountains.

Woodland types.—Several kinds of broadleaf trees are common within the park and compose the woodland types. In Glacier National Park the woodland type is confined generally to moist locations although the aspen type is frequently found on exposed mountain sides. Several very fine stands of aspen (*Populus tremuloides*) occur along the road on the east side of the park. Along the lower end of St. Mary Lake the aspen and balsam poplar (*Populus balsamifera*) make a very beautiful sight in the fall when the leaves are changing color. Red birch (*Betula fontinalis*) is a rather common broadleaf species found frequently in coniferous forests, especially with Douglas fir. Paper birch (*Betula papyrifera*) is common around Lake McDonald and along the Flathead River at Belton together with balsam poplar and aspen.

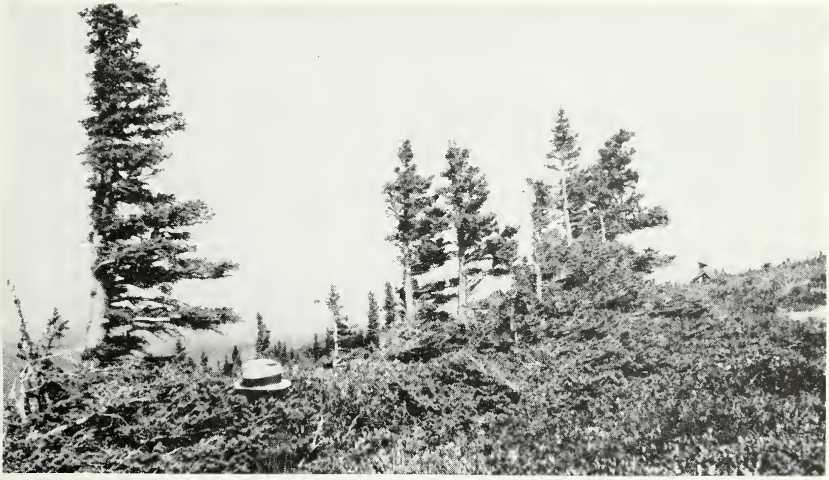

Figure 21.—A windblown Engelmann spruce. Glacier National Park.

Forests of Yellowstone National Park

The area now occupied by Yellowstone National Park has not always been as we see it today. Geologists tell us that millions of years ago, before the Rocky Mountains were formed, the entire region was an inland sea extending over much of the central part of the continent. Slowly the mountain chain was pushed up thousands of feet above sea level. During the long period which followed, a succession of plants followed each other on the exposed land surface until today we have dense forests covering a large portion of the Rocky Mountain region. Most of the Yellowstone area is covered with coniferous forests with lodgepole pine predominating. Alpine fir and Engelmann spruce are next in importance, occurring usually in mixed types, together and with lodgepole pine. Douglas fir is also especially common in canyon bottoms where it is often associated with Engelmann spruce.

Lodgepole pine type (fig. 22).—Lodgepole pine (*Pinus contorta*) is the best known and most common tree in the park, making up nearly three-fourths of the forest cover. It is abundant at lower and middle elevations in pure or mixed stands and extends on up to timber line. The largest stands of pure lodgepole pine occur on the west side of the park. The forests are usually very dense with scarcely any underbrush and often with a great deal of fallen timber.

Limber pine type.—Limber pine (*Pinus flexilis*) occurs abundantly at the north end of the park, commonly mixed with other conifers, the individuals widely scattered. It is a light-loving, drouth-resisting tree occurring most abundantly on the formation of Mammoth Hot Springs in association with Rocky Mountain red cedar (*Juniperus scopulorum*) and scattered Douglas fir (*Pseudotsuga taxifolia*). This species is the first pine seen after entering the park from the north at Gardiner, Mont.

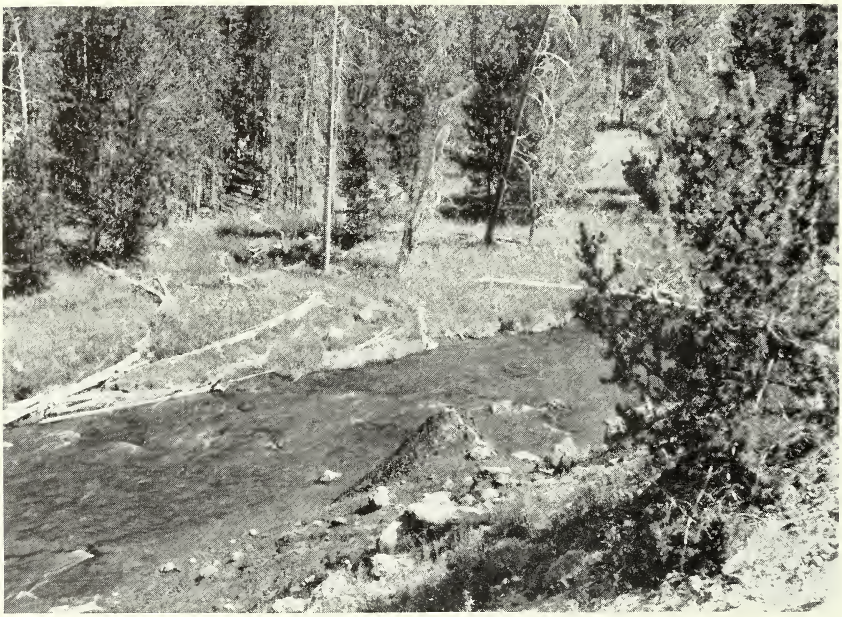

FIGURE 22.—Lodgepole pine near Little Geyser, Gibbon River. Yellowstone National Park.

Whitebark pine type.—Whitebark Pine (*Pinus albicaulis*) is typically a timber-line pine confined to the subalpine slopes and exposed ridges at the higher elevations. It occurs either in pure or mixed stands. The trees are naturally stunted because of the adverse conditions of their habitats, but taller and larger specimens may be found in more protected localities. Mixed stands of whitebark pine (*Pinus albicaulis*), alpine fir (*Abies lasiocarpa*), and Engelmann spruce (*Picea engelmannii*) occur on the slopes of Mount Washburn and on Two Ocean and Mirror Plateaus. It is only occasionally found in association with lodgepole pine.

Alpine fir type.—Alpine fir (*Abies lasiocarpa*), the only true fir in the park, is common at the middle elevations and on up to timber line. In the lower part of its range the trees are quite large and handsome, but higher up they are usually stunted. often forming a matlike ground cover on alpine slopes or ridges. This fir seldom forms pure stands, occurring usually with spruce, lodgepole pine, and white bark pine. Fine stands of alpine fir and Engelmann spruce occur near Crystal Springs, in Firehole Canyon, along the Continental Divide, at Dunraven Pass near Mount Washburn, and near the east entrance to the park.

Engelmann spruce type, (fig. 23).—Englemann spruce (*Picea engelmannii*) is the only spruce found in Yellowstone National Park, although its near relative, the Colorado blue spruce, is common in some areas outside the park. Pure stands occur frequently, chiefly in the southwestern part of the park at the head of Bechler River and Shoshone Creek. Along with alpine fir it is found up to timber line where it becomes spreading and prostrate. Large areas of the spruce-fir mixture are common in the southeastern part of the park.

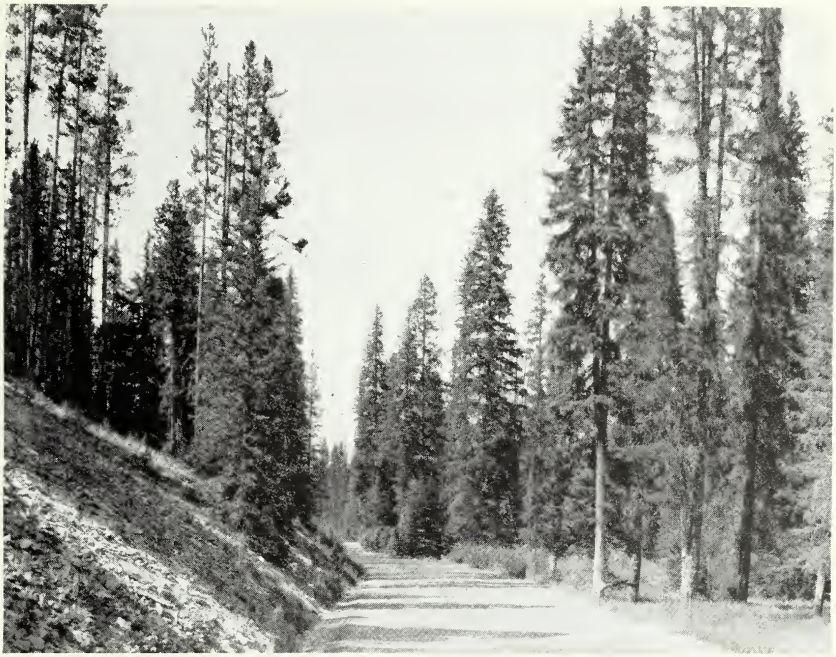

Figure 23.—The highway passes through a grove of beautiful Engelmann spruce near Obsidian Cliff. Yellowstone National Park.

Rocky Mountain red cedar type.—Rocky Mountain red cedar (*Juniperus scopulorum*), resembling to some extent the common red cedar of the East, is a tree of the lower and middle elevations, seldom occurring above 6,000 feet elevation. Its adaptability to semiarid conditions accounts for its common occurrence on dry, rocky slopes and ridges between Gardiner and Mammoth Hot Springs. Occasionally a stunted shrublike specimen of red cedar is mistaken for creeping cedar (*Juniperus horizontalis*) which is always a shrub.

Douglas fir type.—Douglas fir (*Pseudotsuga taxifolia*) is common at middle elevations in the northern part of the park where it prefers the cool canyons and moist slopes. It occurs in pure stands or associated with alpine fir and spruce, or with lodgepole pine. Mixed stands of Douglas fir and lodgepole occur in the area between Mount Washburn and the Grand Canyon of the Yellowstone. In some of the moister areas, as along Cache Creek in the northeast corner of the park, Douglas fir and Engelmann spruce appear to be crowding out the lodgepole.

Woodland types.—Quaking aspen (*Populus tremuloides*) is the most common broadleaf tree, especially at the northern end of the park. It occurs in thickets or groves on moist slopes and along mountain streams at the lower elevations where the trees often become 20 to 30 feet high. It is truly the pioneer tree of this region, reaching out and growing on unclaimed, burned-over areas where it furnishes shade and conserves the moisture which enables other forms of trees to take hold. Occasionally it occurs with Douglas fir, as along Gneiss Creek.

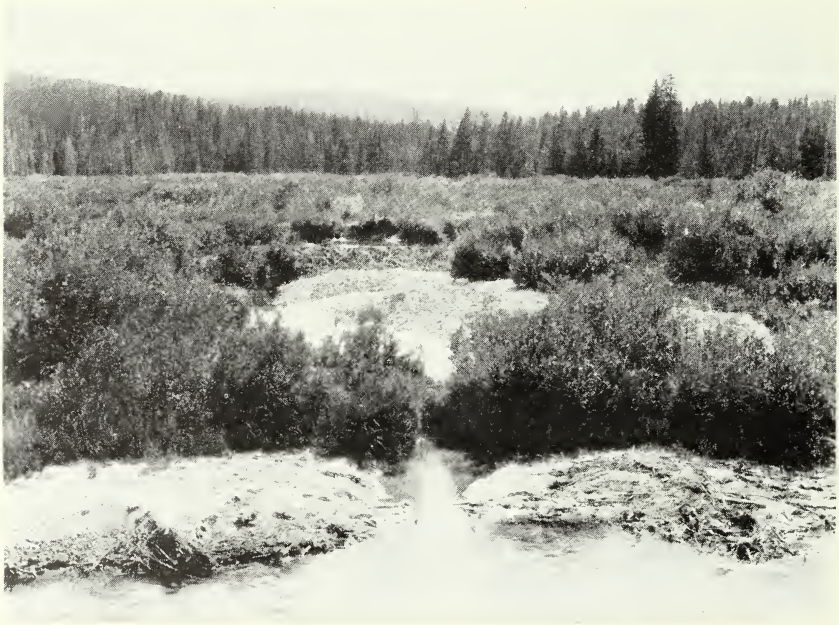

FIGURE 24.—Willow flats (note beaver dam in middle foreground). Yellowstone National Park.

Two other poplars occur in the park, but less commonly. The narrowleaf cottonwood (*Populus angustifolia*), found occasionally along the streams at the lower elevations, becomes a tree of considerable size along the Gardiner River. It has dark-green narrow leaves resembling those of some of the willows. Balsam poplar (*Populus balsamifera*) occurs along the lower parts of the Lamar and Yellowstone Rivers where it becomes the largest of the broadleaf trees. It may be easily distinguished from the narrowleaf cottonwood by its broader leaves which are dark shiny green above and whitish beneath. Willows are also common along the streams, but mostly in shrubby form, often forming dense thickets (fig. 24).

Forests of Grand Teton National Park

The Teton range, 40 miles in length, was formed by the upward tilting of a huge earth block which gently slopes to the west but which rises abruptly from the floor of Jackson Hole on the east. Into this steep eastern face many deep glaciated valleys have been cut. It is only a few miles from the forest-covered base at about 6,000 feet to the western boundary on the crest of the range more than 13,000 feet above sea level. This formidable mountain range, with a large proportion of the area above timber line, has acted as a barrier to the spread of many plants and is thus responsible for the development in the park of a flora which is unique in many respects. There are representative species from the East and West which have migrated this far and could go no farther, being unable to cross the alpine barrier. The general species composition of the flora is similar to that of Yellowstone National Park, which is to be expected since the northern boundary of Grand Teton National Park is only 11 miles from the southern extremity of Yellowstone National Park.

Alpine fir type.—Alpine fir (*Abies lasiocarpa*) covers the largest area of any type in the park. It is the principal constituent of the forest in the canyons and along the higher eastern slopes of the Teton Range, where it occurs in either pure stands or mixed with Englemann spruce, lodgepole pine, Douglas fir, and whitebark pine. It is a very adaptable tree, becoming relatively large at lower elevations but dwarfed and often misshapen at timber line.

Lodgepole pine type.—Lodgepole pine (*Pinus contorta*) is the most common tree at the lower areas in the park and extends up to 8,000 feet. It is found in great abundance surrounding the lakes and on the glacial moraines at the mouths of the canyons, occurring almost entirely as pure stands. In such favorable sites the trees are sometimes 2 feet in diameter. The forests are usually dense, entirely lacking in shrubby undercover, but with the forest floor covered with litter and fallen timber. The trees are easily blown down because of the superficial root system which, although well adapted to the shallow soil of the region, gives very poor anchorage. Thus the fallen trees may lie in tiers and constitute a serious fire hazard. The lodgepole pine is in keen competition with alpine fir and Engelmann spruce. Eventually the fir-spruce forest will take over the lodgepole pine stands since the young fir and spruce trees are much more tolerant of shade. This is evident in areas where mixed stands of lodgepole pine and spruce or fir occur.

Whitebark pine type.—This type is second only to the alpine fir in the area covered. It occurs in greatest abundance along with alpine fir on the higher slopes and ridges, but it may also be found at lower elevations. Trees of this species are among the largest in the park, sometimes attaining 70 feet in height with a diameter of nearly 4 feet. It is interesting to note that, while whitebark pine is usually dwarfed and scrubby on the Pacific slope, it becomes a very sizable tree at Grand Teton National Park (fig. 25). On the other hand, Douglas fir, which is a tree of small stature and of only secondary importance at Grand Teton, becomes one of the largest and most imposing trees in the Pacific Northwest. The long spreading branches and flat top of the whitebark pine easily distinguish it from the tall straight lodgepole, but it is not so easily set apart from the limber pine with which it is often confused. Cones are essential if these two are to be satisfactorily distinguished.

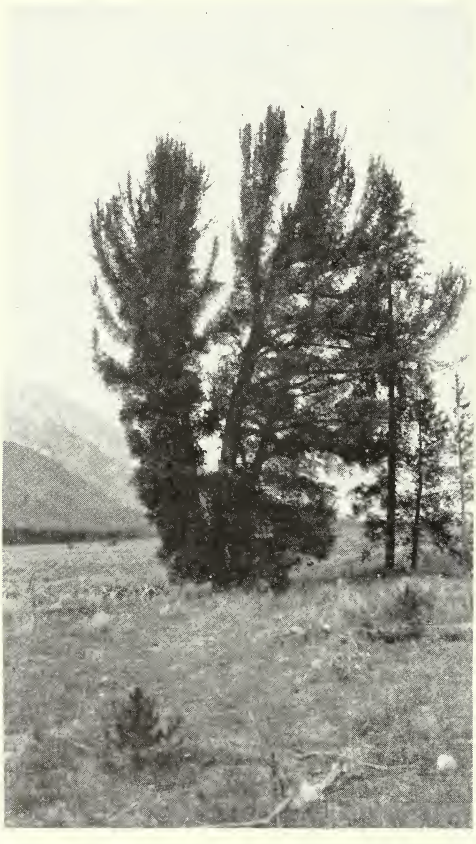

Figure 25.—A specimen of whitebark pine growing at an unusually low elevation in Grand Teton National Park.

Limber pine type.—Limber pine (*Pinus flexilis*) has been observed in only a few localities, but when a more sure means of identification is available it may be found to occur more generally. Some of the finest specimens of limber pine occur on the ridge at the north side of Phelps Lake along the trail to Death Canyon.

Engelmann spruce type.—Engelmann spruce (*Picea engelmannii*) is frequently found in pure stands around the lakes and along streams in the lower regions where the trees attain the largest size of any in the park. Throughout most of the type, however, this tree occurs in association with other species. In the lower parts its chief associates are alpine fir, lodgepole pine, and Douglas fir. Higher, and on up to near timber line, Engelmann spruce in smaller form is associated with dwarfed alpine fir, whitebark pine, and limber pine. At timber line it is very much dwarfed. Another species of spruce, the beautiful blue spruce (*Picea pungens*), is found along the Snake River which touches the park boundary at the southeast corner.

Douglas fir type.—Douglas fir (*Pseudotsuga taxifolia*) forms a comparatively small type at Grand Teton National Park. Pure Douglas fir, which makes up about a fourth of the type, is found in open stands on rocky, southern exposures (fig. 26). Throughout most of the range it occurs with alpine fir and Engelmann spruce, although it is sometimes found with aspen (*Populus tremuloides*).

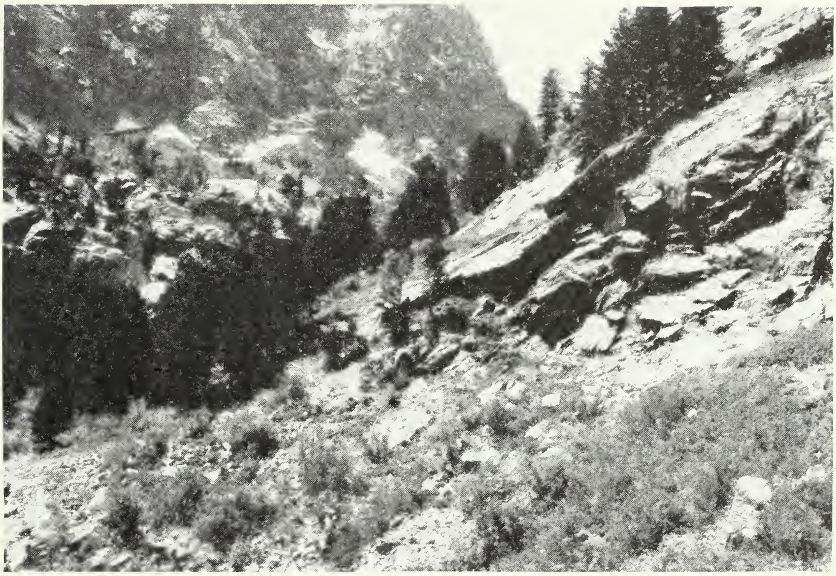

Figure 26.—Douglas fir frequently occupies sunny semibarren slopes in Grand Teton National Park.

Woodland types.—The principal species making up the woodland or stream type is aspen (*Populus tremuloides*). This species covers extensive areas on moist slopes and canyon flats up to about 8,000 feet. At the lower elevations, the trees form beautiful glades, often with trunks nearly a foot in diameter. Higher up they become scrubby or shrublike, sometimes forming dense thickets near streams. In a few localities along the main streams, as at the mouth of Death Canyon, are a few large trees of balsam poplar (*Populus balsamifera*), the largest of any of the broadleaf trees in the park. Another poplar, the narrowleaf cottonwood (*Populus angustifolia*), although rare in the park, is found along the southeastern boundary and is common in association with aspen, along the Snake River just outside the park.

Forests of Rocky Mountain National Park

Entering the park from Estes Park village on the east, the visitor comes first into the dense ponderosa pine forest typical of the lower valleys and foothills. As he proceeds higher, he will note that the ponderosa pine is gradually being replaced by lodgepole pine until at about 9,000 feet the forest in some parts becomes pure lodgepole pine. Above the lodgepole pine belt we come into the extensive forests of Engelmann spruce and alpine fir. These predominate up to timber line with limber pine and lodgepole pine as occasional associates. The trees in the higher subalpine regions occur in scattered groups on grassy slopes and flats. Near timber line and on exposed ridges they become dwarfed and gnarled, often spreading out in low mats on the ground. Above timber line is a great expanse of tundralike country covered with grass, sedges, and rushes, and a few low alpine shrubby plants such as dwarf whortleberry and alpine willows. Looking down from this region to the great glacial-cut canyons, forest-covered far below, gives one the feeling of being "on top of the world."

Spruce-fir type.—This type is the most widespread type in the park, slightly surpassing even lodgepole pine in the area covered. Engelmann spruce (*Picea engelmannii*), the dominant species in the type, is seldom found in pure stands, but is usually associated with alpine fir (*Abies lasiocarpa*). Of the total area covered with spruce, about 80 percent is occupied by the spruce-fir mixture. Limber pine (*Pinus flexilis*) often enters the type, and, occasionally, aspen (*Populus tremuloides*) and lodgepole pine (*Pinus contorta*). The ground cover in this forest is commonly composed of grass and herbaceous species with also some shrubby species, including grouse whortleberry (*Vaccinium scoparium*), Rocky Mountain whortleberry (*Vaccinium myrtillus*), cliffbush (*Jamesia americana*), and willow (*Salix*). This type is typical of the forest belt above the lodgepole pine type, and is common from here to timber line. An especially fine stand of the spruce-fir mixture may be seen at Lawn Lake, southwest of Mummy Mountain.

Lodgepole pine type.—This is the prevailing forest type at low and middle elevations and very common in old burned-over areas where second growth has started. However, some trees may be found even up to timber line on south and west slopes. The area occupied by lodgepole pine (*Pinus contorta*) is only slightly exceeded by the spruce-fir type. The forests are dense and in the lower part of the range there is usually considerable down timber which increases the fire hazard. A common associate is quaking aspen. At higher elevations lodgepole pine is mixed with Engelmann spruce and alpine fir. In the northeast corner of the park in old burns it is being replaced by spruce and fir. In areas where the forests are sufficiently open to support an undercover some of the common species are barberry (*Berberis repens*), buffalo berry (*Shepherdia canadensis*), cliffbush (*Jamesia americana*), grouse whortleberry (*Vaccinium scoparium*), and willows in moist localities.

In open sites antelope brush (*Purshia tridentata*), rabbitbrush (*Chrysothamnus*), and species of sagebrush (*Artemisia*) are sometimes found.

Limber pine type.—Limber pine (*Pinus flexilis*), although not as common in the park as many other species, forms important types. It occurs particularly in the high rocky places, but may be found also at lower elevations as in the lodgepole pine belt. Some of the largest areas covered by the limber pine type are found in the northeast corner of the park on the lower south and east slopes of Mount Dickinson and on the west and south slopes of Mount Tileston and Bighorn Mountain. It is also a dominant type on the north side of Meadow Mountain in the Wild Basin area, extending down to 9,000 feet. The most common associates are Engelmann spruce and alpine fir, but lodgepole pine and Douglas fir also enter the type sometimes. Common shrubby associates are cliffbush (*Jamesia americana*), grouse whortleberry (*Vaccinium scoparium*), dwarf juniper (*Juniperus siberica*), kinnikinnick (*Arctostaphylos uva-ursi*), and willows. Arnica, sedges, rushes, and grass are common herbaceous species.

Ponderosa pine type.—Ponderosa pine (*Pinus ponderosa*) is found mainly in the lower valleys and foothills where it occurs in pure stands or mixed with Douglas fir (*Pseudotsuga taxifolia*), lodgepole pine (*Pinus contorta*) or aspen (*Populus tremuloides*). This is the common forest type in the vicinity of Estes Park village and extends from there up to about 9,000 feet elevation, overlapping somewhat into the lower part of the lodgepole pine belt. The forests are often too dense for much undercover, but where it does occur the following species are common: antelope-brush (*Purshia tridentata*), cliffbush (*Jamesia americana*), big sage (*Artemisia tridentata*), and grass and herbaceous species.

Miscellaneous types.—Douglas fir (*Pseudotsuga taxifolia*) is common only in isolated places in the park, often in association with ponderosa pine and lodgepole pine. It does not form a definite belt as do the ponderosa and lodgepole pines, but usually occurs above them and in association with Engelmann spruce, alpine fir, limber pine, and aspen.

Blue Spruce (*Picea pungens*) is a rare tree in the park, occurring only at the lower elevations below 9,000 feet where it prefers moist stream banks and lake shores. Some fine trees of this species may be seen around Grand Lake in the southwestern corner of the park.

Woodland type.—Aspen (*Populus tremuloides*) is the common woodland species in the park. While it is found scattered all through the park, there are relatively few localities where it occurs as a pure stand and these areas are usually small. The largest stands of aspen are found on the slopes at the upper end of Horseshoe Park where willow is also common. Along most of the streams in the northern part of the park shrub forms of willow are dominant. The wet meadow in the Cache la Poudre River Valley is notable for its willow thickets. Narrowleaf cottonwood (*Populus augustifolia*) and, rarely, balsam poplar (*Populus balsamifera*) are also found along the lower streams.

Forests of Mesa Verde National Park

To most visitors of Mesa Verde National Park the remains of the prehistoric cliff dwellings are the greatest attraction, but the park is also full of botanical and scenic interest. The name, Mesa Verde (Spanish for "green table"), is well chosen because the park lies on the top of a high, heavily forested plateau or tableland which is covered with a blue-green carpet of piñon and Utah juniper interrupted only by occasional patches of sagebrush, or, at the northern end, by extensive thickets of Utah and Gambel oak. Looking south from Park Point, the highest point in the park (8,575 feet), one can look out over this "green mesa" and see in the distance the almost parallel canyons cutting it from north to south. The ruins of the cliff dwellings are found in the nearly perpendicular walls of these canyons (fig. 27). North from Park Point one looks down 2,000 feet to the Montezuma and Mancos Valleys above which the Mesa Verde plateau has been raised.

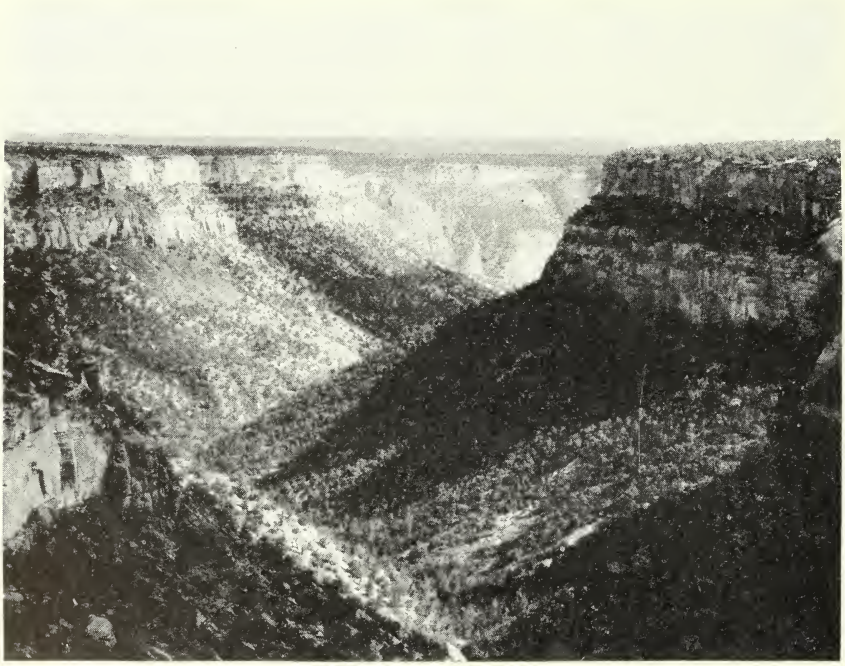

Figure 27.—Typical view down one of the several canyons in Mesa Verde National Park

It is quite evident that the forest cover of Mesa Verde National Park is the same today as it was a thousand years ago. Examination of materials found in the prehistoric ruins shows that piñon, Utah juniper, Rocky Mountain red cedar, and Douglas fir were used in making beams, poles, and ladders for the houses. The ceilings were lined with the wood of lemonade sumac, Utah juniper, and Utah oak. The walls, plastered with adobe, were reinforced with willow sticks. Further, there are still preserved cradle boards, bows, and planting sticks made from ponderosa pine, oak, and juniper. In fact, there is scarcely an important plant in the park which cannot be related to the life of those prehistoric peoples, either for food or for their dwellings.

Piñon-juniper type.—The piñon-juniper type makes up the typical forest cover of the tablelands of the Southwest at elevations of 6,000 feet up to about 8,000 feet. On the Mesa Verde plateau this forest receives more yearly rainfall than is common further south and, consequently, the park is covered with a forest which is among the most luxuriant in the region. Piñon (*Pinus edulis*) and Utah juniper (*Juniperus utahensis*) are the dominant trees on the flat areas, especially in the south portion of the park and they occur also in less dense stands along with shrubby species, on the steep canyon walls. Rocky Mountain red cedar (*Juniperus scopulorum*) may also be present. The shrubs usually associated with this forest are service berry (*Amelanchier bakeri*), mountain mahogany (*Cercocarpus montanus*), cliff rose (*Cowania stansburiana*), lemonade sumac (*Rhus trilobata*), fendlera (*Fendlera rupicola*), and in places, Gambel oak (*Quercus gambelii*), and Spanish bayonet (*Yucca baccata*). Cactus species are also common.

Douglas fir type.—There are only a few relatively small areas of this type in the park, mostly at the north end and on north-facing slopes. Douglas fir (*Pseudotsuga taxifolia*), although relatively unimportant, forms pure stands in most of the areas in which it occurs. Two small patches occur in Spruce Canyon at the south end of the park near park headquarters. The most easily located patch is just below Spruce Tree House where there is considerable moisture. Spruce Canyon was named because of the presence of Douglas fir which has also been called Douglas spruce.

Ponderosa pine (*Pinus ponderosa*) is found occasionally in the park in small pure stands.

Woodland type.—This type is so uniformly composed of Utah oak (*Quercus utahensis*) and Gambel oak (*Quercus gambelii*) that it can be spoken of as an oak type. It forms the dominant cover on many of the hill slopes and canyon sides at the northern end of the park, often forming almost impenetrable thickets. The chief associate is service berry (*Amelanchier bakeri*). Mountain mahogany, fendlera, and snowberry (*Symphoricarpos rotundifolius*) also occur and, in places, squaw-apple (*Peraphyllum ramosissimum*). Aspen (*Populus tremuloides*) is found in a few localities at about 8,000 feet. A small patch occurs in the Prater Canyon drainage at the head of a side canyon and another may be found at the head of a short north-facing draw just east of Park Point. Balsam poplar (*Populus balsamifera*) occurs sparingly in a few localities along the lower streams.

Forests of Bryce Canyon National Park

Bryce Canyon National Park is actually not a canyon but a long series of intricately eroded breaks along the edge of the Paunsaugunt Plateau where it drops off into the Paria Valley 1,000 to 3,000 feet below. The park embraces a long strip of territory within which are cut at least 14 bowl-shaped amphitheaters filled with figures of domes, spires, and temples. The largest of these amphitheaters is known as Bryce Canyon, in honor of Ebenezer Bryce, a Mormon pioneer. It is located in the same general region as Zion Canyon, but, whereas the center of interest at Zion National Park is in the magnificant main canyon, sometimes described as a "Yosemite done in oils," at Bryce visitors are attracted by the amazing variety of fantastic figures carved by erosion from the bright-colored cliffs.

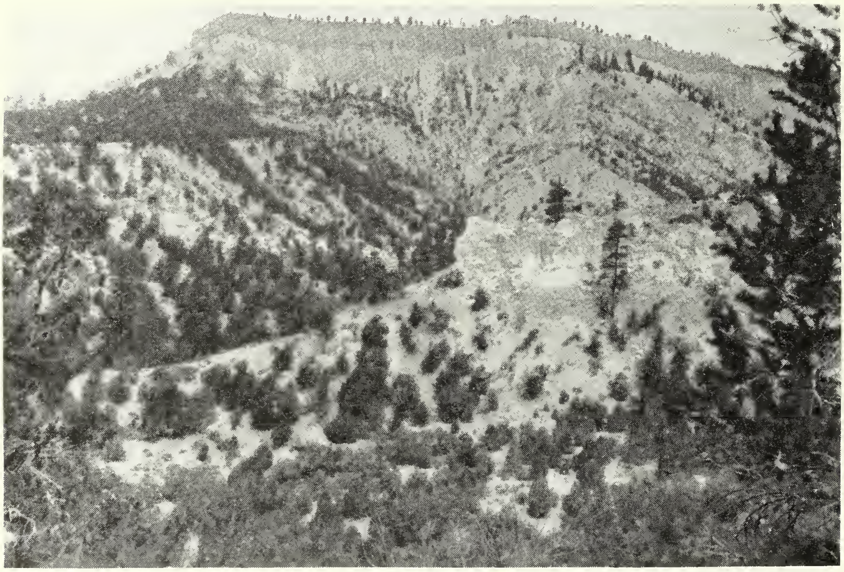

Figure 28.—A sparse cover of trees and shrubs clothes the canyon slopes of Bryce Canyon National Park.

Within the bounds of the park are many conditions which modify the climate of the region, and, consequently, the vegetative cover. The south-facing cliff walls and talus slopes are hot and dry while the north-facing slopes and the deep-shaded canyons are comparatively moist and cool. The high plateau along the rim above and the stream-sides in the bottoms of some of the canyons offer still different climatic conditions. On the plateau, about 8,000 to 9,000 feet in elevation, are found coniferous forests typical of truly mountainous regions, including ponderosa pine, Douglas fir, and white fir. The hot, dry slopes support a rather thin stunted growth of piñon-juniper with a scattering of shrubs (fig. 28). Bristlecone pine also forms small types in the park. Since permanent streams are few in the park, the woodland type is not common but it does occur in a few localities.

Ponderosa pine type—The ponderosa pine (*Pinus ponderosa*) type covers the largest area in the park. At the northern end of the park on the west side the species occurs in pure stands with scarcely any undercover. In the more rugged country to the east the forest is more open with a conspicuous amount of shrubby growth. Common shrubs are manzanita (*Arctostaphylos patula*), mountain mahogany (*Cercocarpus montanus*) and (*Cercocarpus ledifolius*), bitterbrush (*Purshia tridentata*), and Gambel oak (*Quercus gambelii*). In a few places on the warmer canyons sides, as on Boat Mountain, the pine is found associated with Douglas fir (*Pseudotsuga taxifolia*), but this is uncommon.

Pine-fir type.—The pine-fir type covers the main plateau area on the west side of the park just south of the ponderosa pine type. It is composed of ponderosa pine, Douglas fir, and white fir (*Abies concolor*) with very little undercover. This is the predominant type along the road to the Natural Bridge.

Douglas fir type.—South of the pine-fir type the ponderosa pine is replaced entirely by Douglas fir (*Pseudotsuga taxifolia*) and white fir. This type predominates just east of the Natural Bridge and south to Rainbow Point. Douglas fir occurs occasionally in small pure stands on north-facing slopes. Ordinarily the trees are small, but along the Navajo trail in a cool, moist, sheltered gorge a particularly fine specimen of Douglas fir is found which is approximately 125 feet tall and 5 feet in diameter. This shaded gorge approximates the climate of Washington and Oregon probably better than any other place in Bryce Canyon National Park and as a result the tree appears more as if it were growing in the humid Northwest instead of in the semiarid Southwest.

Piñon-juniper type.—This type is found principally on the eastern side of the park. It is composed of piñon (*Pinus edulis*) and Rocky Mountain red cedar (*Juniperus scopulorum*). On the hot, dry slopes the trees are dwarfed and rather sparsely distributed. The shrubby associates occasionally occurring in the type are birch-leaf mahogany (*Cercocarpus montanus*), curl-leaf mahogany (*Cercocarpus ledifolius*), and greenleaf manzanita (*Arctostaphylos patula*).

Forests of Zion National Park

Although Zion Canyon is especially noted for its spectacular vari-colored walls composed of layers of red and white sandstone, it is safe to say that a great deal of its charm and interest would be lost if it were not for the vegetative cover, especially the trees. The Virgin River winding through the canyon is marked by a line of broadleaf trees which furnish much welcomed shade and help to hold the stream to a certain course, especially during periods of flood. Also, the hot, dry talus slopes would be desolate indeed if it were not for the trees and shrubs. Anyone who has taken either of the trails to the rim of the canyon and has experienced the terrific glare of the sun on the white sandstone can testify to the importance of the shade offered by the trees along the way. In certain of the protected spots where there is a constant trickle of water down the walls of the canyons, the hanging gardens, with the willows, ashes, and maples below, are among the beauty spots of the park.

The forests of Zion National Park may be divided into three distinct types. The broadleaf forest on the floor of the canyon is composed chiefly of Fremont cottonwood, narrowleaf willow, black willow, boxelder and desert ash. Along the river all become large spreading trees, while in the shallow side canyons where the water supply is much less, they may be found as smaller, more straggling forms. These trees can stand the hot sun if they are constantly supplied with water and in many localities they have advanced for miles out on the deserts along water courses.

The talus slopes along the face of the steep canyon walls, while not far distant from the floor of the canyon, have an entirely different type of forest. Exposed all day as they are to the direct sun and located a considerable distance above the streams, these slopes can support only a type of vegetation able to endure conditions of drought. The piñon-juniper forest, rather dwarfed in form, is the chief forest cover, often in association with extensive patches of scrub oaks. In a few places near the bases of cliffs are found small springs where it is not uncommon to find broadleaf trees similar to those of the canyon floor.

On the high plateau areas, 2,000 to 3,000 feet above the canyon floor, are found very luxuriant forests. Here the climate is typical of the highland country as is shown by the predominance of ponderosa pine. Pure stands occur on the higher sections of the plateau, especially on the northwest side of the canyon and coming down as low as 6,000 feet in the gullies and protected areas. A few fine trees may be seen along the East Rim Trail in Echo Canyon. White fir is also sometimes found in the deep canyons. The largest stand known to occur in the park is at the bottom of Refrigerator Canyon on the West Rim Trail.

The remainder of the plateau region in the lower parts, chiefly on the southeast side, is covered to a great extent with a fine piñon-juniper forest. The trees are much more luxuriant-looking than the scrubby specimens on the hot, dry talus slopes in the Canyon. A good example of this type of forest is found at Inspiration Point.

The forests are interspersed with areas of brushland on the ridges with occasional meadows or patches of grassland in some of the valleys. On moist flats and along streams on both sides of the plateau may be found rather extensive patches of aspen.

The history of Zion Canyon has been unusual. In very early days the canyon floor, as well as the river bottom below, was settled by the Mormon pioneers and their cattle ranged far up into the canyon. Trees were cut from the forests on the plateau and the timber was lowered to the canyon floor. It is said that in 1909 and 1910 3 million board feet of ponderosa pine were logged off. Young trees are now gradually replacing the cut timber, but, as everywhere in this arid region, tree growth is extremely slow.

Owing to erosion started by overgrazing at the headwaters of the Virgin River, floods washed away the rich soil of the farm lands below and it finally had to be abandoned although the canyon was used for a while longer as a range for livestock. In 1915 a hard winter found the animals without feed. Every bit of forage was gone. The settlers were forced to go up and cut the cottonwoods to get bark for the stock to eat. In spite of the harsh treatment during former days the vegetation has succeeded in regaining to a considerable extent a normal appearance.

Ponderosa pine type. Ponderosa pine (*Pinus ponderosa*) covers the greatest area of any forest type in the park. It is the chief forest cover over the northern part of the park and on the east side. The forests are mostly open with a shrubby undercover of such species as service berry (*Amelanchier alnifolia*), Utah oak (*Quercus utahensis*), Big sage (*Artemisia tridentata*), mountain mahogany (*Cercocarpus montanus*,) and some manzanita (*Arctostaphylos patula*).

Piñon-juniper type.—This type is common on the dry slopes of the canyon walls, but the largest area occurs in the southwestern quarter of the park. The principal species are Utah juniper (*Juniperus utahensis*), Rocky Mountain Red Cedar (*Juniperus scopulorum*), singleleaf piñon (*Pinus monophylla*), and piñon (*Pinus edulis*). The forests are mostly rather open and composed of rather scrubby-looking trees with an undercover of low chaparral, including such species as holly oak (*Quercus pungens*), manzanita (*Arctostaphylos patula*), antelope-brush (*Purshia tridentata*), service berry (*Amelanchier alnifolia*), and Utah oak (*Quercus utahensis*).

On the rims of the canyons are also smaller areas of piñon-juniper scattered about at the higher elevations. In these regions the forests are often quite dense and luxuriant-looking.

Woodland type.—The woodland type may be divided into two sections, the aspen type on the plateau at the higher elevations, and the mixed type along the permanent streams in the canyons. The aspen type is found for the most part in the northern part of the park along streams or on moist slopes or flats. A fine stand may be seen at the southern end of Horse Pasture Plateau near the northern boundary. The Virgin River (fig. 29) is lined on both sides with large broadleaf trees including both tree and shrub forms of willow, Fremont cottonwood (*Populus fremontii*), and often boxelder (*Acer negundo* var. *interius*), and leatherleaf ash (*Fraxinus velutina* and var. *coriacea*). In many places along the streams shrubby forms of willow and other moisture-loving shrubs form thickets beneath the trees. Canyon wild grape (*Vitis arizonica*) is occasionally found.

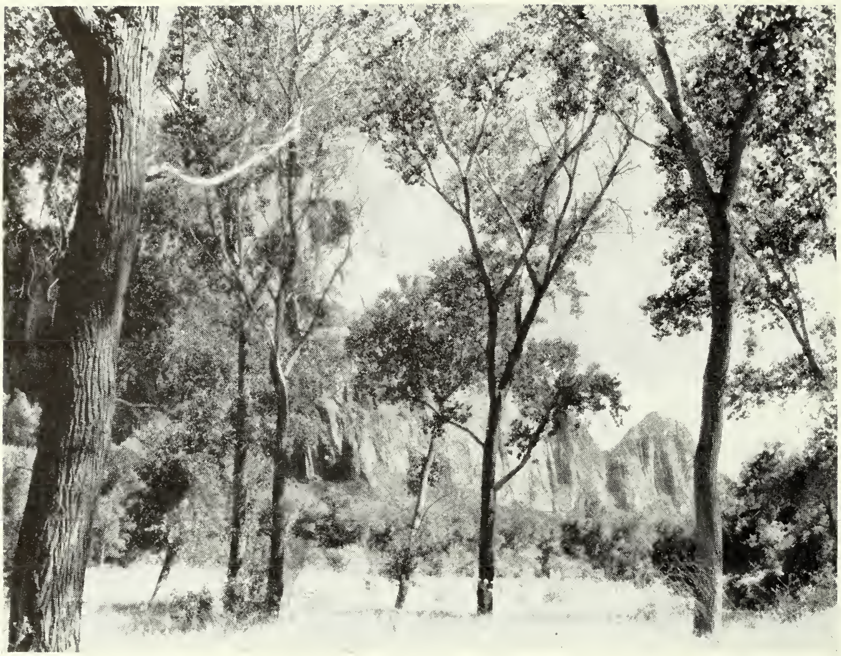

FIGURE 29.—Woodland type along the Virgin River in Zion National Park.

Forests of Grand Canyon National Park

Grand Canyon National Park includes within its boundaries a section of the Grand Canyon of the Colorado 56 miles long and 4 to 18 miles wide. In addition to the bright colors and magnificent geologic formations for which it is so famous, this canyon has a very interesting and varied vegetation cover which does much to enhance its charm and soften its rugged beauty (fig. 30). The large number and variety of plants which have been identified within the park is due mainly to the great differences in altitude, resulting in great extremes of moisture and temperature. Within a few hours' time one can go from the cool coniferous forests at about 8,000 feet elevation on the canyon rim to a hot desert climate with a typical desert flora in the bottom of the canyon, and all within the park boundaries. The forest types occur principally on the plateau above the canyon on the North and South Rims. The North Rim is from 1,000 to 1,500 feet above the South Rim in elevation and hence there is a great difference in the forest cover on the two sides. That of the North Rim is singularly beautiful, composed predominantly of tall stately trees of ponderosa pine and white fir in varying degrees of predominance. A belt of piñon and Utah juniper occurs on the canyon walls just below the rim. The forest cover on the South Rim is primarily an open piñon-juniper type with ponderosa pine coming in at the eastern end (fig. 31).

Piñon-juniper type.—This forest type covers by far the largest area in the park. It forms the chief cover on the South Rim and on the flat tops and upper slopes of the temples and other formations within the canyon. Also there is a considerable area with a rather sparse cover of piñon-juniper and shrub species on the exposed canyon slopes below the North Rim. Piñon (*Pinus edulis*) and Utah juniper (*Juniperus utahensis*) are the main trees in this type. In a few localities, as in the Upper Nankoweap and in Bright Angel Canyon, specimens of singleleaf piñon (*Pinus monophylla*) occur. The piñon-juniper forests are as a rule rather open with an undercover of shrubby species. Common shrubs are big sagebrush (*Artemisia tridentata*), Utah service berry (*Amelanchier utahensis*), cliffrose (*Cowania stansburiana*), manzanita (*Arctostaphylos pungens*), New Mexican locust (*Robinia neomexicana*), blackbrush (*Coleogyne ramosissima*), and shrub live oak (*Quercus turbinella*).

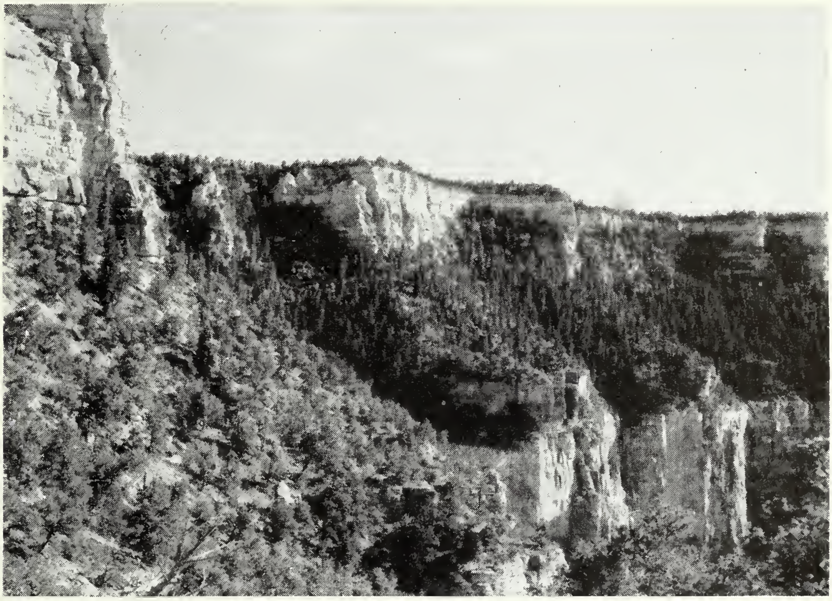

FIGURE 30.—The vegetation cover at Grand Canyon National Park does much to soften the rugged beauty of the canyon.

Ponderosa pine type (fig. 32).—Ponderosa Pine (*Pinus ponderosa*) as a type makes up the main forest cover on the North Rim, especially along the edge of the rim and on the main points projecting out into the canyon. It occurs in pure stands or associated with aspen (*Populus tremuloides*), or sometimes with blue spruce (*Picea pungens*). It is the predominating tree species on Point Sublime and on Tiyo Point. There are also extensive stands of ponderosa pine on the South Rim towards the east end, but here it is associated with Utah oak (*Quercus utahensis*) or sometimes with piñon and Utah juniper. Shrubs are occasionally found in the ponderosa pine

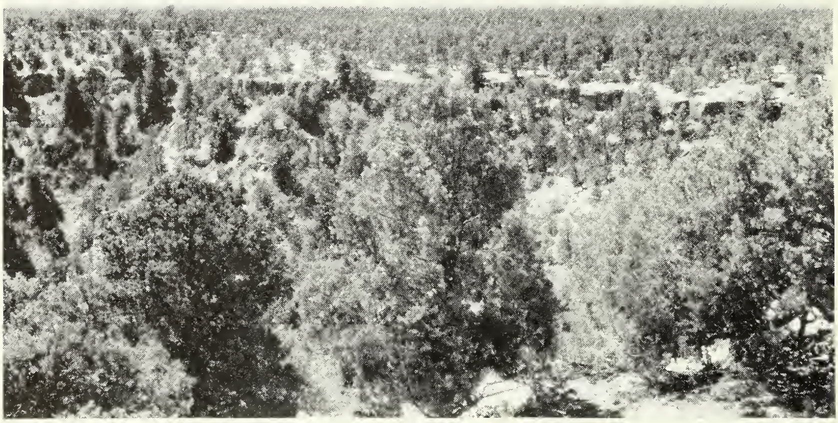

Figure 31.—Piñon-juniper type on the South Rim at Grand Canyon National Park.

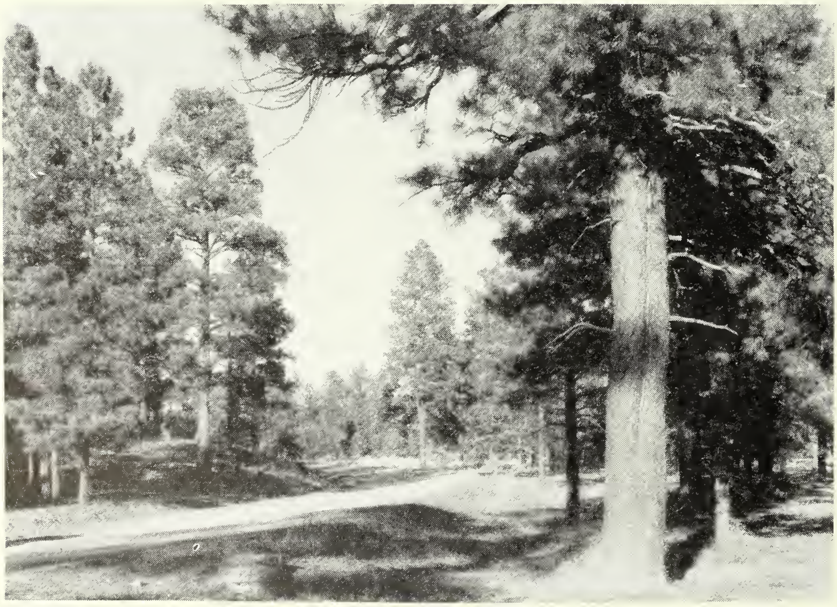

Figure 32.—Ponderosa pine type. Grand Canyon National Park.

type such as big sagebrush (*Artemisia tridentata*) and cliffrose (*Cowania stansburiana*). In many places there is considerable herbaceous ground cover.

Pine-fir type.—This type, found almost entirely on the North Rim and usually some distance back from the edge of the rim, is composed chiefly of two species, ponderosa pine (*Pinus ponderosa*) and white fir (*Abies concolor*). Aspen and Douglas fir (*Pseudotsuga taxifolia*) are frequent associates. The stands are characteristically open with a thick layer of duff on the forest floor. The type as a whole is singularly beautiful and is inhabitated by many kinds of wildlife. In some areas the work of porcupines is evident. They ordinarily prefer the pine bark but at Lancelot Point fir bark has been utilized also.

Fir type.—This type is composed principally of white fir (*Abies concolor*) (fig. 33), commonly in association with Douglas fir. A few patches of the firtype may be found near Grandview.

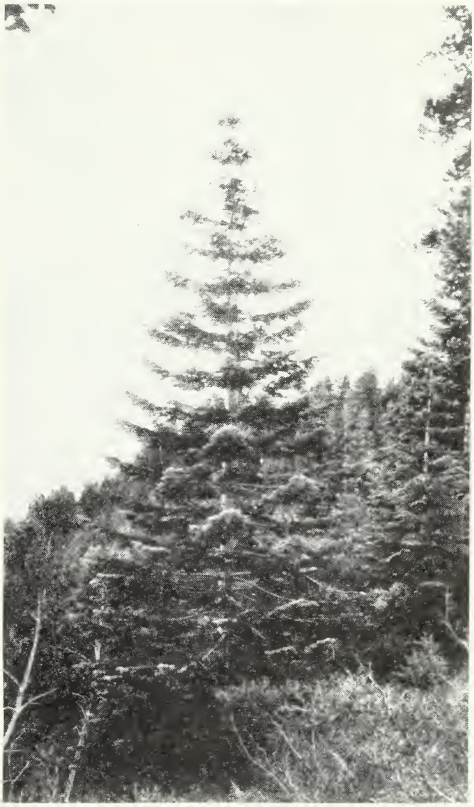
Figure 33.—White fir. Grand Canyon National Park.

Spruce type.—This type is generally found bordering small meadows or scattered through grassy canyon bottoms chiefly on the North Rim. Blue spruce (*Picea pungens*) and aspen (*Populus tremuloides*) are the dominant species (fig. 34), usually with a sprinkling of white fir or alpine fir. Grass and other herbaceous species are usually present as a ground cover, although underbrush is not common. The forest floor is generally covered with a heavy layer of humus and there is considerable dead and down aspen in these areas. On some of the north- and west-facing slopes there is frequently a dense undercover of young trees and dwarf juniper.

Woodland type.—Two distinct kinds of woodland occur in the park, one on the North Rim and the other in the canyon. That on the North Rim is made up primarily of aspen (fig. 35) which is common on moist slopes and flats, usually in pure stands. Humus and litter often form a thick carpet

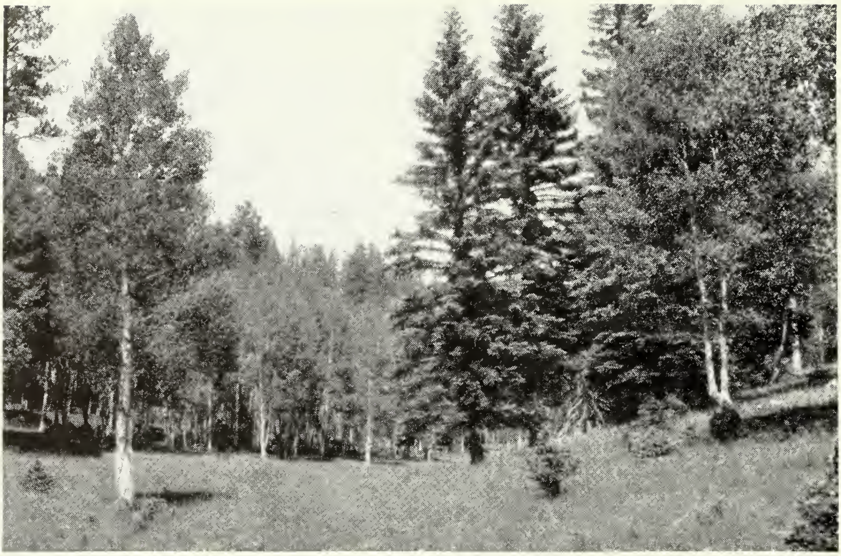

Figure 34.—The blue spruce-aspen forest is a common type on the North Rim at Grand Canyon National Park.

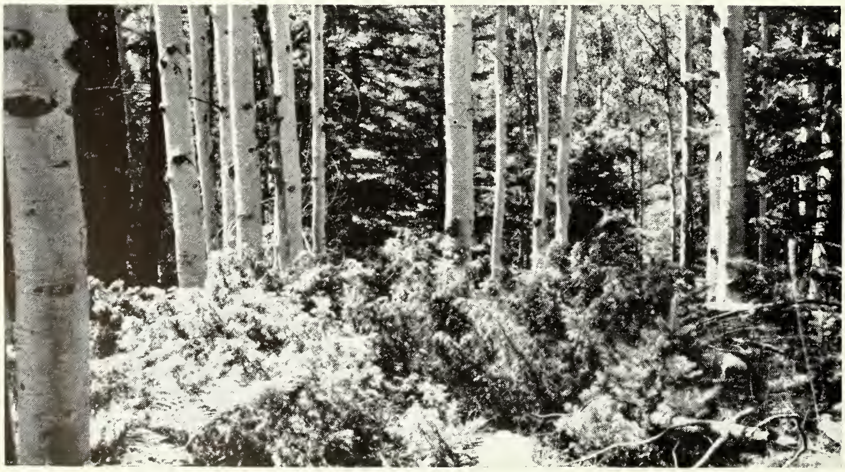

Figure 35.—Aspen. Grand Canyon National Park.

on the damp forest floor. The second type, which occurs mainly along streams in the side canyons, is composed chiefly of catclaw (*Acacia greggii*) and Fremont poplar (*Populus fremontii*). The shrubs usually represented in this type are a scrub live oak (*Quercus turbinella*) and willow. Many of the species are important browse on the winter range for both deer and desert bighorn.

Forests of Wind Cave National Park

Wind Cave National Park is located in the famous Black Hills region of southwestern South Dakota. The area was set aside in 1903 and now includes 12,640 acres, part of which is used as a game preserve. Buffalo, elk, antelope, and deer range the preserve which consists to a large extent of rolling plains. This section has a fascinating story to tell of the prehistoric and long extinct animals which were once found there. Plants likewise existed there which did not even remotely represent the forest now covering the slopes of the Black Hills. The cave lies in the great Pahasapa limestone which contains several other large subterranean caverns. It is said that the discovery was made by a pioneer who was attracted by a strange whistling noise. Strong air currents blowing in and out of a natural opening, not more than 10 inches in diameter caused this noise. The strange wind phenomenon is believed to have been caused by a difference in the atmospheric pressure between the inside and outside of the cave.

The vegetation cover of the park is comparatively simple with approximately half of the area forest-covered and the rest grassland. The forest which is comparatively open with an undercover of grass and herbaceous plants, is made up almost entirely of ponderosa pine. This type covers 42 percent of the park area. The trees are relatively small, averaging about 35 feet in height, with diameters seldom more than 20 to 24 inches. Rocky Mountain red cedar (*Juniperus scopulorum*) is a tree common along the stream bottoms, although it occurs also on the rolling grasslands and is occasionally seen on the steep rocky side hills.

The broadleaf woodland type is confined to the streams in the northern and central parts of the park and along the main drainages in the southeastern corner. It occurs occasionally as pure types, but more often forms mixed stands consisting of boxelder (*Acer negundo violaceum*), American elm (*Ulmus americana*), and balsam poplar (*Populus balsamifera*).

Very little shrubby growth is found in the park except in a few isolated areas. The two predominant brush species are mountain mahogany (*Cercocarpus montanus*) and snowberry (*Symphoricarpos racemosa*). The latter shrub is most abundant along the stream bottoms but is also found quite generally throughout the park. The mountain mahogany is limited in occurrence and found presumably on old burned areas.

In the grassland area in the south-central part of the park there are noticeable areas of *Yucca glauca* and cactus. These are generally located on the exposed ridge noses and are frequently adjacent to or in the areas occupied by Rocky Mountain red cedar. Although the *Yucca* does not occur as a dominant type, it is quite common throughout the park and is found in all types except that of the stream bottom. It occurs most frequently on the crests of rises and in the drier sites in the grassland areas. Another shrub which is very often found associated with *Yucca* is the lemonade sumac (*Rhus trilobata*). The plant occurs in several types, particularly in the eastern and central parts of the park.

Forests of Carlsbad Caverns National Park

Carlsbad Caverns National Park, located in southeastern New Mexico, covers some 49,568 acres and ranges in altitude from 3,600 to 4,698 feet. The plant cover is typically that of the Upper Sonoran Zone except at the southern end of the park where it is Lower Sonoran. Although the general appearance of the vegetation is unspectacular, the area contains many interesting desert plants and during April or May one may see many of them in bloom. The flowering period is usually very short for most of the species.

Many of the plants which occur in the area show peculiar adaptations resulting from the necessity for the retention of water. The various cacti and cactus-like plants have developed enlarged stems for storing water during the short rainy season in which not more than 10 inches of rain falls. As a means of reducing evaporation, many of the plants of the region, such as the catclaw, have developed very small leaves. The ocotillo sheds its leaves entirely during the hot summers, while the cactus and allthorn are entirely without leaves, thus reducing the surface from which evaporation may take place. In other cases leaves may have a waxy or varnished-like surface, as in the creosotebush, or a hairy covering, as in the sages. As defensive structures, many of the desert plants such as the cactuses, allthorn, catclaw, and ocotillo, have developed spines and thorns. These protect them from being eaten.

The lowest part of the area is in the southern half where a large flat extends into the park for nearly a mile from the southern boundary. Here the terrain rises abruptly some 600 feet to a rather flat plateau about three-quarters of a mile wide and which extends east and west for most of the length of the park. This plateau then dips into a canyon and again rises about 500 feet to another plateau, the northern end of which is the northern boundary of the park. Walnut Canyon, winding through the park from west to east forms the main drainage of the area. Bat Canyon, a smaller drainage, roughly parallels Walnut Canyon from park headquarters to the eastern boundary. The composition of the vegetation varies considerably on the flat, on the plateaus, and on the bluffs. Still other types occur on the walls of the two canyons and in the canyon bottoms.

At the southern edge of the park the vegetation consists dominantly of grass, with a sprinkling of the following shrub species which vary in dominance throughout the areas. Acacia (*Acacia tortuosa*) is very noticeable when in bloom because of its small round clusters of yellow flowers. Where it grows thickly, it forms impenetrable walls because it is well armed with thorns. It is found in almost pure types along the base of the bluff which overlooks the southern part of the park. Creosotebush (*Larrea tridentata* var. *glutinosa*), also with yellow flowers, is usually the dominant plant on the areas where it grows. It occurs mainly on the southern part of the flat. Seepwillow (*Baccharis glutinosa*), is easily noted from a distance because of its light green foliage.

In the eastern portion, soaptree (*Yucca elata*) enters the type and in a few areas, cholla (*Opuntia imbricata*) occurs. One-seeded juniper (*Juniperus monosperma*) is occasionally found along the margins of creek beds, and cactus species are sparsely scattered throughout the area but are most prominent near the bluffs where the surface is rocky. A few trees of hackberry (*Celtis reticulata*) are scattered throughout the southwest part of the flat and in the southwest corner a few trees of allthorn (*Koeberlinia spinosa*) are also found. On the face of the bluff to the north of the flat the vegetation is rather open due to the steepness of the slope. Ocotillo (*Fouquieria splendens*) is the dominant species and occurs in practically all of the types.

Woodland type.—In the canyon bottoms is found a woodland cover type composed of walnut (*Juglans rupestris*), desert willow (*Chilopsis linearis*), oak (*Quercus grisea*), catclaw (*Acacia*), maple (*Acer*), madrone (*Arbutus texana*), hackberry, wild cherry (*Prunus*), and other broad-leaved trees. This type is scattered over the park in narrow strips along the canyons.

Forest type.—The high areas in the north and west portion of the park are covered on the north and east exposures with an open coniferous forest. Ponderosa pine (*Pinus ponderosa*), piñon (*P. edulis*), and alligator juniper (*Juniperus pachyphloea*), together with madrone (*Arbutus texana*), oak, and other plants of the semidesert chaparral make up this type.

Forests of Mount McKinley National Park

Mount McKinley National Park, situated in south-central Alaska, covers a vast wilderness with ice-capped peaks, grinding glaciers, and sphagnum-covered foothills sweeping down to spruce forests in the valleys. The forest found here is quite different from that of the coastal area to the west which is in reality a gradually narrowing belt of the mixed coniferous forest found in Oregon and Washington. About 90 percent of the forest cover of Mount McKinley National Park is made up of white spruce (*Picea canadensis*), a tree of somber foliage and with clusters of tawny cones. Larch (*Larix laricina*) is found in a few places, predominating along the Toklat River.

Of the broadleaf trees the most abundant is the quaking aspen found along benches and on the sides of the mountains where the ground has plenty of moisture, usually at fairly low elevations. The black cottonwood and graceful paper birch are found in similar locations but usually at somewhat lower altitudes. Willows occur abundantly. Some are small trees, some shrublike, and on the higher alpine slopes and ridges they occur in matlike growths only a few inches high. In order to escape the rigors of the climate, these low plants hide their woody stems underground, thrusting to the surface only the elongated clusters of their flowers and a few conspicuously net-veined leaves during the brief summer season. Species of willow are the only trees which grow above an altitude of 3,000 feet, the dwarf form often being found 4,000 to 5,000 feet above sea level.

Forests of Hawaii National Park[5]

Hawaii National Park is unique among the parks in that it consists of two separate tracts of land lying on two separate islands, the Kilauea-Mauna Loa section on the island of Hawaii and the Haleakala section on the island of Maui. The park area includes regions with many different kinds of climate. Within a relatively small area these islands offer extremely diverse ecological conditions to land plants, forms of which may occur from sea level to an altitude of almost 14,000 feet. They may have tropical heat throughout the year or a freezing temperature for much of the time on the tops of the peaks. They may grow under conditions of extreme aridity or in areas of almost constant rainfall.

The origin of a number of the plant species which inhabit these islands may be traced to many different lands. Spores and seeds were brought to the islands by wind, birds, and ocean currents, and man has purposely and accidentally introduced numerous species. Centuries ago many plants were brought by the Polynesian people who discovered the islands. Because of the isolation of the islands and the unusual environmental conditions, a good many of the plants which came to the islands in ages past have become greatly modified so that today there are species found growing here and no other place in the world, some of them confined to a "single mountain ridge, valley, or oasis."

Visitors to Hawaii, although primarily attracted by the volcanoes, are also interested in the luxuriant tropical vegetation on the islands. No temperate zone trees occur here except those, such as mesquite, which have been introduced. The forests may be visualized as being divided into five horizontal zones between sea level and up to about 11,500 feet. These may again be divided into two phases, the dense junglelike forests of the districts of heavy rainfall chiefly along the windward side, and those of the drier regions on the leeward side. The section of the park on the island of Hawaii includes examples of all five of the zones, with the two upper containing both wet and dry phases.

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[5] Adapted from Lamb, S. H., Trees of the Kilauea-Mauna Loa Section: Nat. Hist. Bull., no. 2, 1936.

The vegetation in the three lower zones is usually not seen by most park visitors, but may be found along the approach road from Hilo. In the lowest zone, known as the strand or beach zone, the cocoanut palm (*Cocoa nucifera*) is perhaps the most common and characteristic tree and has a special fascination to visitors. From sea level to approximately 1,000 feet elevation is the lowland zone, the zone of cultivation, and consequently the one in which introduced trees are most abundant. Along the coast in this zone is the peculiar screwpine (*Pandanus tectorius*) with its long stiff leaves edged with sharp spines. The lower forest zone extends from 1,000 feet to 2,000 feet and it is in this region that the tropical forest begins to be most interesting. Only the dry phase is represented in the park. Here is found the widely branched candlenut tree or kukui (*Aleurites moluccana*) which is abundant on the lower slopes of the mountains, particularly in the ravines. It sometimes attains a height of 90 feet but is usually only half that size. It stands out conspicuously in the forest because of its light greenish-gray foliage against the dark green of the other trees. The nuts were strung together on sticks and used by the natives to light their houses, hence the name candlenut tree.

The most popular area of the Kilauea section of the national park is located in the middle forest zone from 2,000 to 5,000 feet. In this zone are represented both wet and dry phases with many intermediate areas. Here the two most common forest trees reach their greatest development. One, the ohia or ohia lehua (*Metrosideros collina* var. *polymorpha*), is chief among the trees of the wet forests. Its brilliant pompons of scarlet or yellow flowers are very showy during the flowering season. This tree occurs, often in pure stands, from sea level to the summits of all but the highest mountains but with its greatest development in the middle forest. Many of the old idols were made from the wood of this tree. Tree ferns also are common from sea level to 10,000 feet elevation, but in these wet middle forests they often form dense jungles. The other tree common to the middle forest but representative of the dry phase is the koa or Hawaiian mahogany (*Acacia koa*). This is one of the largest trees on the islands, many trees being more than 70 feet high. It occurs in pure or mixed stands. It is from the trunks of these trees that the natives in times past made their war canoes.

The highest zone, known as the upper forest, extends from about 5,000 to 11,500 feet. Characteristic of this forest zone is the mamani (*Sophora chrysophylla*), a species found only in the Hawaiian Islands. This tree with its clusters of beautiful golden-yellow pealike flowers occurs on most of the larger islands and may be seen in the park area a few miles from Kilauea crater and in the lava desert near the entrance to the park. A moderately wet phase may be seen along the trail leading to the summit of Mauna Loa. Most of the Haleakala section of the park on the island of Maui is located within the upper forest zone. Much of the crater proper and the south and west sides of the rim are dry, while the area covered by the head of the Halemaumau Trail is quite wet.

Although forests occur on seven of the eight Hawaiian Islands and cover a fourth of the total land surface, they are at present very greatly depleted because of severe overgrazing and unchecked fires which have occurred during the last century. Prior to a hundred years ago the only source of destruction to timber was the overflow of lava from the volcanoes. With the clearing of lands for plantations and the introduction of exotic plants and of livestock, including cattle, horses, sheep, and goats, the number of native plants has been considerably diminished. In some parts of the islands, especially in the lowlands, it is said that one can scarcely find a remnant of the native Hawaiian vegetation.

Field Guide to the Trees With Needlelike Leaves

Cone-bearing trees

I. Firs and fir-like trees; leaves short, flattened on the upper side or square in the cross-section outline, borne singly on the twigs.
  A. Cones borne erect on the upper branches; leaves spreading in two opposite directions or curving upwards; round, smooth scars left on the twigs when the leaves fall . . . . *Firs*, p. 68
  B. Cones hanging downwards; leaves spreading from all sides of the twigs, or crowded on the upper side.
    1. Leaves sharp-pointed at the tips, borne on tiny pegs which remain on the twigs after the needles fall . . . . *Spruces*, p. 75
    2. Leaves not sharp-pointed at the tips.
      (a) Cones with long 3-pointed tonguelike bracts protruding from between the cone scales . . . . *Douglas fir*, p. 77
      (b) Cones without tonguelike bracts protruding from between the cone scales . . . . *Hemlocks*, p. 79

II. Trees with slender, needle-shaped leaves borne in group.
  A. Needles in bundles of 1, 2, 3, or 5; enclosed by a papery sheath at the base; evergreen trees . . . . *Pines*, p. 81
  B. Needles, many in brushlike tufts on stout woody pegs (borne along the branches), the leaves falling each year . . . . *Larches*, p. 95

III. Trees with small, pointed, awl-shaped or scalelike leaves overlapping each other on the twigs.
  A. Cone-bearing trees.
    1. Leaves scalelike and closely pressed to the twigs . . . . *Cedars*, p. 95
    2. Leaves awl-shaped, spreading a little from the twigs . . . . *Big Tree*, p. 99
  B. Trees having berrylike fruits . . . . *Junipers*, p. 95

Trees With Firlike Leaves and Fleshy Fruits.

I. Leaves sharp-pointed; fruits plum-like; occurs only in California parks. *California nutmeg*, p. 102

II. Leaves pointed at the tips but not prickly; fruits small red berries; occurs only in the parks of the Pacific Northwest . . . . *Yew*, p. 103

Fir (*Abies* Link)

Seven species of fir are represented in the western national parks.

White fir type.—This species has a rather wide distribution. It occurs in the California parks, at Crater Lake National Park, and in two parks of the Southwest. The largest areas are found in Yosemite National Park, where it covers thousands of acres as a dominant type and an even greater area in other forest types.

Silver fir type.—This type occurs only in Mount Rainier and Olympic National Parks where it forms the most common forest type at intermediate elevations. It covers nearly 42,000 acres at Mount Rainier National Park, often in association with western hemlock, Douglas fir, or at higher elevations, with mountain hemlock.

Red fir and noble fir types.—The red fir type, including the variety Shasta fir, occurs in the Cascade and Sierra Nevada parks. It is the predominant fir in each of the parks in which it occurs. The largest area covered by the red fir type occurs at Yosemite National Park. Nearly an equal area is covered by Shasta fir at Sequoia National Park. The irregularity in the distribution of red fir and the variety Shasta fir offers an interesting problem. Shasta fir is found in Sequoia and Crater Lake National Parks, while red fir dominates the area in between, occurring in both Yosemite and Lassen Volcanic National Parks.

Noble fir has often been confused with Shasta fir because of the similarity in the appearance of their cones. Noble fir occurs only at Mount Rainier National Park.

Alpine fir type.—Alpine fir is the most widespread of the fir species. It is the only fir type present in the Rocky Mountain parks and it is the common high elevation type in the Pacific Northwest. It frequently occurs in canyon bottoms or on mountain slopes up to timber line, usually in association with Engelmann spruce, mountain hemlock, or various species of pine. Whitebark pine and limber pine are the most common pine associates of alpine fir.

At Glacier National Park alpine fir covers nearly as much area as does lodgepole pine, the most common type in the park. At higher elevations in Grand Teton National Park it is also the principal constituent of the forest along the eastern slope of the Teton range. At Yellowstone National Park this fir occurs frequently at the lower elevations, mixed with lodgepole pine, while at higher elevations it occurs either in pure stands or mixed with Engelmann spruce and Douglas fir. At Rocky Mountain National Park the fir rarely occurs as a dominant type, invariably subdominant to Engelmann spruce.

In our Pacific Slope parks alpine fir is a common high elevation tree at Mount Rainier and Olympic National Parks and occurs as far south as Crater Lake National Park. It also occurs at the very highest elevations on the Kaibab Plateau in the Southwest region. Here, as in the Rocky Mountain region, it is commonly associated with Engelmann spruce, but in the Pacific Slope parks mountain hemlock is the common associate in the fir type. In Mount Rainier and Olympic National Parks it is the chief constituent of the forest at high elevations, occurring either in pure stands or in association with mountain hemlock and Alaska cedar. At Crater Lake National Park the tree is comparatively rare as a type but is much more common as an associate species in other types.

Field Guide to the Species of Firs

I. Tree having the leaves spreading in opposite directions on the twigs, at least on the lower branches.
  A. Leaves approximately the same length on the branchlets, spreading horizontally.
    1. Found only in the Pacific Northwest . . . . 1. *Lowland white fir.*
    2. Found in Crater Lake National Park, in the California Parks, and in the Southwest . . . . 2. *White fir.*
  B. Leaves in two series, the longer spreading opposite each other the shorter leaves on top of the twig closely overlaying the others; found only in the Pacific Northwest . . . . 3. *Silver fir.*
II. Trees having the leaves crowded on the upper side of the branches; leaves turning upwards, making the twigs bushy above.
  A. Cones with long tonguelike bracts protruding from between the cone scales, the bracts turning down and closely pressed against the cone.
    (1) Leaves with a groove down the middle on upper side; found only at Mount Rainier National Park . . . . 4. *Noble fir.*
    (2) Leaves with a ridge down the middle on the upper side; found at Crater Lake and Sequoia National Parks . . . . 5. *Shasta fir.*
  B. Cones with no tonguelike bracts protruding from between the cone scales.
    (1) Sturdy trees with large cones, inner bark red, found in Lassen Volcanic and Yosemite National Parks . . . . 6. *Red fir.*
    (2) Slender spirelike trees; cones small, purplish and clustered at the tops of the trees; found in the Pacific Northwest, Crater Lake National Park, and in the Rocky Mountain parks . . . . 7. *Alpine fir.*

1. **Lowland white fir** (*Abies grandis* Lindl.).—Lowland white fir is a forest tree of the Northwest but with a quite limited distribution in the national parks. This tree prefers moist situations and hence occurs chiefly near streams or in basins in the lower mountains. It is rarely found in pure stands but is commonly mixed with Douglas fir, western red cedar, and western hemlock. Lowland fir may be distinguished from silver fir by its leaves which spread horizontally from the branchlets, at least on the lower limbs, whereas the silver fir has both horizontally spreading leaves and shorter leaves along the tops of the branchlets. It is similar in many ways to white fir, but the two would scarcely be confused in the national parks because of their difference in distribution.

Description.—Tree 80 to 200 feet tall, with remarkably straight trunk 1½ to 3 feet in diameter, branches tending to droop slightly and then turn up at the ends; bark about 1 to 2 inches thick, pale red-brown with an ashy tinge; the lower leaves flat and blunt with a distinct notch at the tip, 1 to 2 inches long, standing out horizontally from the lower branches, shorter and more crowded on the upper side of the upper branches; cones yellow-green, oblong, slender, about 2 to 4½ inches long, 1 to 1⅓ inches wide.

Occurrence.—Olympic, occasional, up to 2,300 feet: Junction of Godkin Creek and Elwha River. Mount Rainier, occasional 2,000 to 3,000 feet: Near park boundaries along White River, Puyallup River, and the Nisqually Entrance. Glacier, occasional: McDonald Valley at Sprague Creek campground.

2. **White fir** (*Abies concolor* Lindl.).—This is a beautiful forest tree of the southern Cascades and Sierra Nevada, occasionally found also in the Southwest. It occurs in greatest abundance on cool, moist slopes at medium high elevations where it is generally associated with ponderosa pine, sugar pine, Douglas fir, incense cedar, and sometimes lodgepole pine. It seldom forms pure stands over large areas. White fir may be distinguished from red fir, which occasionally occurs in the same area, by the ashy-gray bark in contrast to the reddish-brown bark of the red fir. Also the lower leaves tend to spread out horizontally from the lower branches instead of curving upwards as in red fir. The cones, borne toward the top of the tree (fig. 36), are cut by squirrels and stored for winter use. The scales are stripped from the cones one by one and the seeds eaten out.

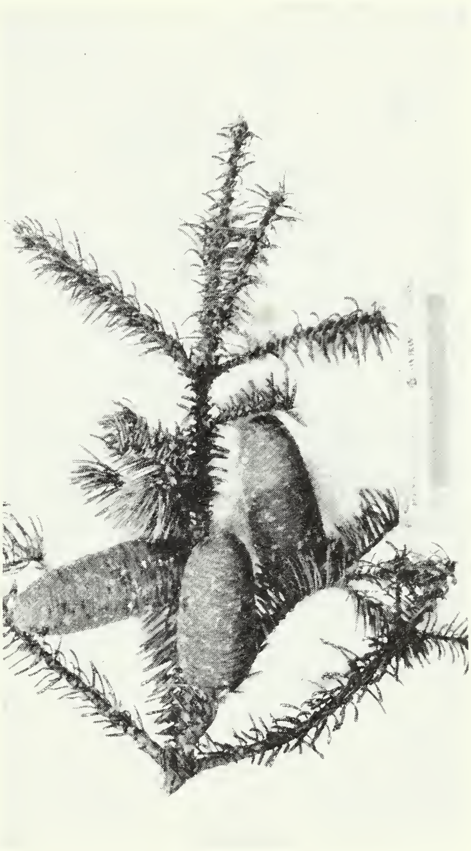

Figure 36.—White fir cones.

Description.—A symmetrical tree 30 to 180 feet high with a narrow crown and a trunk 1 to 6 feet in diameter; bark ashy-gray and roughly furrowed, or, in young trees, smooth and grayish-white, often with blisters; leaves ½ to 2½ inches long, flat, the lower spreading horizontally from the two sides of the branchlets, the upper turning upwards; cones brown when ripe, oblong, 2 to 5 inches long, erect on the branches, falling to pieces on the tree; cone-scales roundish and finely-toothed, each bearing 2 winged seeds.

Occurrence.—Crater Lake, common, 4,500 to 6,200 feet: Annie Creek; along Sun Creek; west side of Timber Crater; near south boundary. Lassen, common, 5,200 to 7,500 feet; north side of Reflection Lake; Lassen Peak. Yosemite, abundant, 4,000 to 8,500 feet: Lower end of Yosemite Valley; Hetch-Hetchy Valley; ridge west of Lake Tenaya; Merced Lake; Washburn Lake; Waterwheel Falls, Tuolumne Valley. Sequoia, abundant, 4,500 to 9,800 feet; Giant Forest; Bearpaw Meadow; Atwell Mill; West of Little Baldy. Bryce, common, 7,500 to 9,000 feet; Oak Hollow; head of Podunk Creek; Rainbow Mountain; Natural Bridge; Union Pacific Spring. Zion, rare, 4,500 to 6,500 feet: Refrigerator Canyon between the Organ and Angels Landing; upper Emerald Pool. Grand Canyon, 5,700 to 9,000 feet: North Rim, abundant on the Kaibab Plateau. South Rim, common in shaded sites just below the rim; Grandview.

3. **Silver fir** (*Abies amabilis* (Dougl.) Forbes).—Silver fir, also called lovely fir, is one of the most beautiful firs in the West. The tree is very striking because of its smooth ashy-gray bark marked with chalky-white areas. This is the most common fir at the middle elevations in Mount Rainier National Park. It occurs in pure stands but is more commonly mixed with western hemlock, western red cedar, and Douglas fir.

Description.—Tall, handsome tree, 75 to 200 feet tall, with rounded crown and drooping branches; trunk straight and clean or, in the open, with branches down to the ground; bark smooth ashy gray on young trees, dark, rough, and ridged on the old; foliage dense, deep lustrous green; leaves about ¾ to 1 inch long, the longer leaves spreading horizontally, the shorter overlaying the others on the top of the branchlets; cones dark purple, about 4 to 5½ inches long, about 2½ inches thick, erect, falling to pieces on the tree.

Occurrence.—Olympic, abundant, 2,000 to 4,200 feet; Elwha River Valley; Low Divide; North Fork Quinault River; Enchanted Valley; below Anderson Pass; Duckabush River; Dosewallips River; Elk Lake. Mount Rainier, abundant, 2,000 to 4,500 feet: Longmire-Paradise Road; Sunrise Ridge Road.

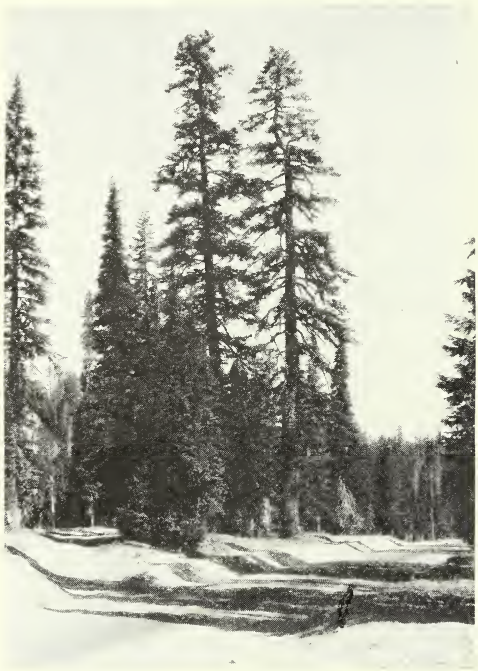

FIGURE 37.—Shasta fir. Crater Lake National Park.

4. **Noble fir** (*Abies nobilis* Lindl.); 5. **Shasta fir** (*Abies magnifica var. shastensis* Lemmon) (fig. 37); 6. **Red fir** (*Abies magnifica* murr).—These are among the most magnificent trees found on the Pacific slope. The species are all similar in general appearance and have a deep red inner bark which distinguishes them from white fir which has a buff-colored inner bark. The main distinction between the species is in the cones which are larger than those of any other fir in the parks. In red fir the cone scales are broad and rounded with the upper edges curling outward. Noble fir and Shasta fir both have long tonguelike bracts which turn back over the cone scales and lie close to the cone, giving it a shingled effect (figs. 38 and 39). These two species may be distinguished by the needles which are ridged down the middle of both sides in Shasta fir but have a narrow groove down the middle of the upper side in noble fir.

Description.—Tall, symmetrical trees, 125 to 200 feet tall, with trunks 2 to 5 feet in diameter, the crown narrow, composed of horizontal stiff-looking branches; bark of young trees whitish, that of older trees dark reddish-brown, deeply and roughly furrowed in red fir and Shasta fir, finely ridged in noble fir; foliage dark blue-green with a whitish or silvery tinge; needles about ½ to 1 inch long, ridged down the middle in red fir and Shasta fir, grooved down the middle of the upper surface in noble fir, curved upward and densely crowded on the tops of the branches; cones erect, oval, 2 to 3 inches wide, 4 to 8 inches long, at first light green, later becoming yellowish-brown, falling to pieces on the tree.

Occurrence.—Noble fir, Mount Rainier, common, 3,500 to 5,000 feet: Sunrise Ridge road at hairpin turn; slope above Ohanapecosh Hot Springs; trail from Mowich Lake to Tolmie Peak. Shasta fir, Crater Lake, abundant, 6,000 to 8,000 feet: Annie Springs; along the road north of Union Peak; Crater rim; Wizard Island; Sun Creek west of Maklaks Pass. Sequoia, abundant, 7,000 to 11,000 feet: Circle Meadow; Alta Peak Trail; Panther Peak Trail; west of Little Baldy; northeast of Marble Falls. Red fir, Lassen, abundant, 5,700 to 8,000 feet: Lassen Peak; Reflection Lake; Juniper Lake. Yosemite, abundant, 5,500 to 9,500 feet: Tuolumne Meadows; Rancheria Mountain; near top of Yosemite Falls; Lake Tenaya; Pohono trail; road between Chinquapin and Glacier Point.

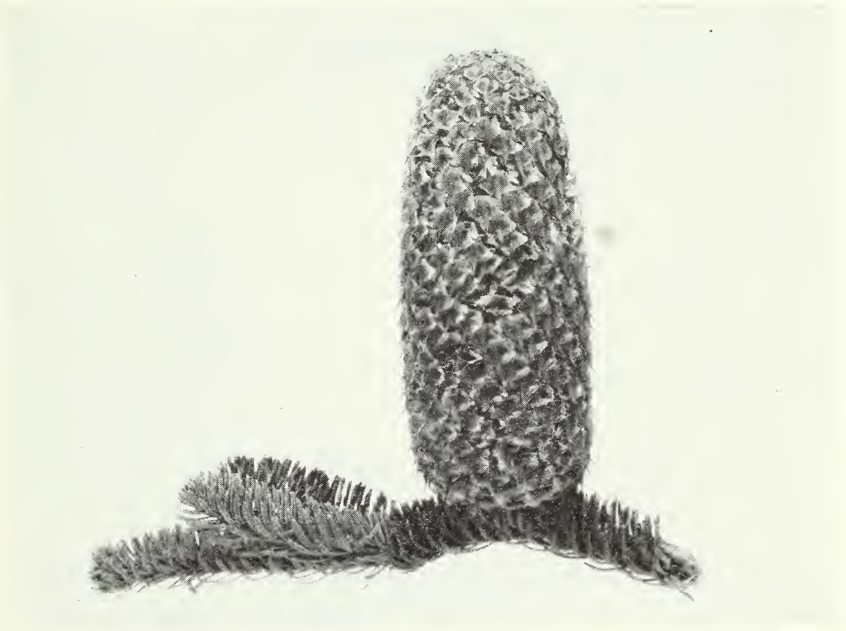

FIGURE 38.—Noble fir cone.

7. **Alpine fir** (*Abies lasiocarpa* Hook. Nutt.).—Alpine fir, besides being the smallest, is the most widely distributed and perhaps the most easily recognized of western firs. Its narrow, compact crown ending in a spire-like point is a distinctive character. The tree is common at high elevations in cool, moist situations on slopes, in valleys, and meadows, and about mountain lakes. In the Rocky Mountain parks it is one of the most

abundant of the conifers, often forming dense stands. At timber line it is usually beaten down by heavy winds to form mats only a few feet high. This fir is rather unique in that its cones usually appear thickly clustered on the short branches at the top of the tree (fig. 40). The Blackfeet Indians are said to have used the resin from this tree to burn for incense in their ceremonials and it was also used for poultices in the treatment of fevers and colds.

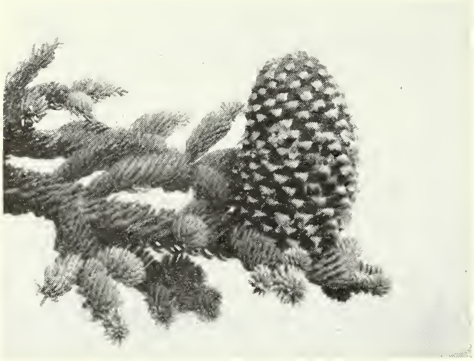

Figure 39.—Shasta fir cone.

Description.—A slender tree up to 100 feet tall, or higher in favorable locations; bark smooth and whitish, often with balsam or pitch blisters; branches heavily clothed with luxuriant foliage; lower branches drooping and often hiding the short trunks; leaves about 1 to 2 inches long, flat, usually notched at the tip, deep blue-green above, whitish below, rather stiff and usually curving upwards; cones about 2 to 4 inches long, 1 inch wide, purple, erect, densely crowded on the short topmost branches, falling to pieces on the tree.

Occurrence.—Olympic, abundant, 4,000 to 6,000 feet; Bogachiel Peak; Glacier Meadows; Mount Carrie; Martins Park; Queets Divide; Marmot Lake. Mount Rainier, abundant, 4,500 to 6,500 feet: Paradise Valley; Yakima Park; Grand Park; Shriner Peak; Tipsoo Lake; Mystic Lake; Indian Henrys Hunting Ground. Crater Lake, occasional, 6,000 to 8,000 feet: Crater rim; Annie Creek canyon; Wizard Island; Sun Meadows Camp Ground; west side of Munson Point. Glacier, abundant, 4,000 to 9,000 feet: Lake Josephine; Logan Pass; Swiftcurrent Lake; Flattop Mountain. Yellowstone, abundant, 7,000 feet to timber line: Near east entrance; Sylvan Pass; near Chocolate Pots; Mount Washburn; Turtle Rock. Grand Teton, abundant, 8,000 to 10,750 feet: Jenny Lake area; in all canyons. Rocky Mountain, abundant, 9,000 to 12,000 feet: Trail Ridge Road; Glacier Gorge; Dream Lake; Fall River Road. Grand Canyon, North Rim, occasional, 8,200 to 9,000 feet; Kaibab Plateau.

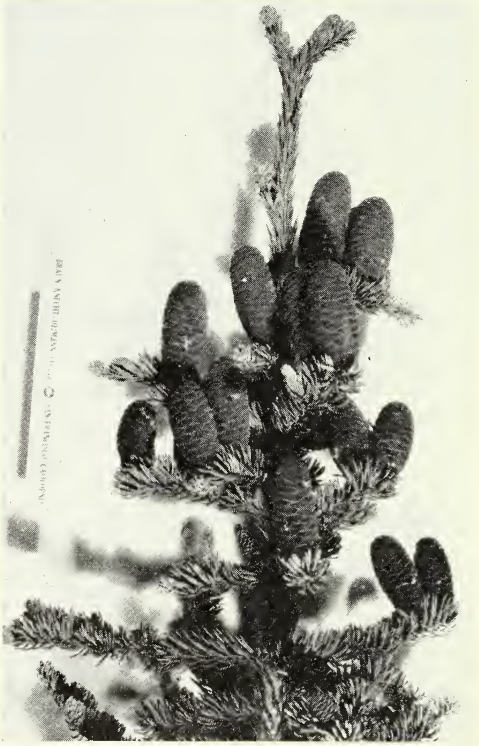

Figure 40.—Alpine fir.

Spruce (*Picea* Link.)

Forest types.—Of the four species of spruce in the western national parks, Engelmann spruce is the most common. This species is typically a tree of the Rocky Mountain region, being rare or absent in the other parks. It makes up more than a quarter of the forested area of Rocky Mountain National Park in association with alpine fir, reaching from intermediate elevations to nearly timber line at about 12,000 feet. At Grand Teton and Yellowstone National Parks also the Engelmann spruce-alpine fir association is common. At Glacier National Park the spruce-fir type is common at intermediate and at high elevations, but the spruce also occasionally occurs in pure stands along stream bottoms or in other favorable moist situations.

Engelmann spruce is rare or lacking in the parks along the Pacific Slope. At Mount Rainier National Park it occasionally occurs in small stands on the north side of the mountain. At Crater Lake National Park a few small patches occur in shaded, moist canyons near the Pinnacles. In the Southwest parks Engelmann spruce occurs only at Grand Canyon National Park on the Kaibab Plateau, often in association with alpine fir.

In the Southwest blue spruce is common on the North Rim at Grand Canyon National Park. It usually occurs on north-facing slopes back from the rim and has a grass and herbaceous undercover. At Bryce Canyon National Park scattered patches of blue spruce frequently occur in the shade of cliffs or in other moist places. In the Rocky Mountain parks a few scattered trees may also occur.

In addition to the two species of spruce already mentioned above, Sitka spruce is common on the West side of Olympic National Park and a few scattered trees also occur at Mount Rainier National Park. Canada spruce is found in Glacier National Park in the vicinity of Belton.

Field Guide to the Species of Spruce

I. Leaves four-sided in cross section.
  A. Young branchlets hairy, cone scales squarish to rounded on the ends .... 1. *Engelmann Spruce*
  B. Young branchlets without hairs.
    1. Leaves soft and flexible; cone scales with squarish ends and smooth margins .... 2. *White spruce.*
    2. Leaves rigid, sharp-pointed, cone-scales tough with flexuous margins, tapering to a rounded or angular tip .... 3. *Blue spruce.*
II. Leaves flattened in cross section, cone-scales ragged on margin ...... 4. *Sitka spruce.*

1. **Engelmann spruce** (*Picea engelmannii* (Parry) Engelm.).—The spruces are easily distinguished from the firs and from Douglas fir by their thick, pointed leaves thickly set all around the branchlets, making them prickly to the touch (fig. 41). When the leaves fall, the twigs are left rough because of the short leaf bases or "pegs" remaining. Engelmann spruce is found at relatively high altitudes. It favors moist locations but may be found on drier hillsides up to timber line. At Grand Teton it becomes the largest of

any tree in the park. Wherever bare soil is exposed the seeds may sprout and the seedlings establish themselves, often forming an understory in the mature forest. A disagreeable pungent odor is emitted when the needles are crushed. This character is often used as an aid in identifying the tree.

Description.—Large tree, 80 to 100 feet high, often 150 feet, with a narrow pyramidal crown of short branches, in open stands with drooping lower branches which may reach the ground; bark dark purplish brown, scaly; foliage blue-green, sometimes with a silvery tinge; needles 4-angled, soft and flexible, with short flat points; cones about 1½ to 3 inches long, light or dark brown, hanging from the upper branches; cone scales thin and flexible, somewhat squarish on the ends or sometimes pointed and notched.

Occurrence.—Mount Rainier, occasional, 4,000 to 5,900 feet: Chenuis Ridge; Lodi Creek Valley; Winthrop glacier moraine. Crater Lake, rare. Pinnacles. Glacier, abundant, 3,600 to 6,500 feet: McDonald Creek; Lake McDonald Hotel; Waterton Valley; Nyack Valley. Yellowstone, abundant, 7,000 feet and above: Near east entrance; West Thumb; Upper Firehole River; Darrows Pass; along highway near Obsidian Cliff; head of Bechler River. Grand Teton, common, 8,000 to 10,000 feet: Canyon bottoms and moist sites; Bradley Lake; head of Open and Granite Canyons. Rocky Mountain, abundant, 9,500 to 12,000 feet: Trail Ridge Road. Grand Canyon, occasional on the North Rim; north and west-facing slopes of the Kaibab Plateau.

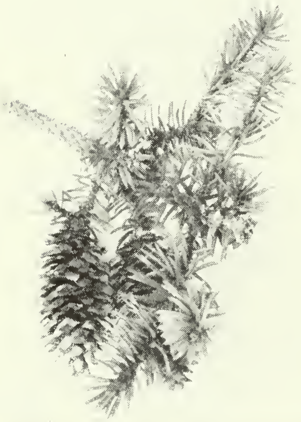

FIGURE 41.—Engelmann spruce.

2. **Western white spruce** (*Picea glauca albertiana* Rehder).—This spruce is found only in Glacier National Park. It ranges through Canada and northeastern United States. It closely resembles Engelmann spruce but may be distinguished by its smooth branchlets, sharp-pointed needles, and broad cone scales with broad squarish ends. The cones are very elastic and regain their shape when crushed in the hand. The leaves have the same characteristic pungent odor as do the leaves of Engelmann spruce.

Description.—A tree 80 to 150 feet high and 1 to 3 feet in diameter, the crown symmetrical and spirelike; bark thin and flaky with ashy-brown scales; leaves blue green, sharp-pointed, ½ to 1 inch long, four sided in cross section, arising on all sides of the twig but twisted and crowded on the upper side; cones 1½ to 2 inches long, the scales flexible and elastic, with broad squarish ends and smooth margins.

Occurrence.—Glacier, occasional: Flathead River near Belton.

3. **Blue spruce** (*Picea pungens* Engelm.).—Blue spruce is very similar to Engelmann spruce in form and general appearance, but the needles are very stiff and rigid, strongly incurved, and with long sharp points. These trees probably have the harshest foliage of any trees found in the parks. Hence the common maxim among naturalists, "grasp the foliage if you would know the blue spruce." The botanist distinguishes Engelmann spruce from blue spruce by a white fuzz which is found on the stems of the new shoots of Engelmann spruce but which does not occur on blue spruce.

Description.—Tree 80 to 100 feet high with a thin symmetrical crown; branches rigid, spreading horizontally from the trunk of the tree; bark gray, tinged with cinnamon-red, scaly in young trees, ridged in the old; foliage dull bluish-green, sometimes with a silvery-white tinge; leaves very stiff and rigid, with long sharp points, 4-angled and strongly incurved; cones hanging from branches on the uppermost part of the tree, becoming pale chestnut brown; cone scales flat and tough.

Occurrence.—Grand Teton, rare, 6,400 feet: Menor Ferry bridge at Moose, near eastern park boundary. Rocky Mountain, occasional: Grand Lake. Bryce, rare, 8,400 to 8,900 feet: Under cliffs, northeast of Rainbow Mountain; Podunk Valley. Grand Canyon, common on the North Rim: Kaibab Plateau.

4. **Sitka spruce** (*Picea sitchensis* (Bong.) Carr).—Sitka spruce is common along the coast in the Pacific Northwest but is rare in the national parks. It is a very handsome and stately tree, having a pyramidal crown, narrow and sharp at the top. When grown in open stands it is very broad at the bottom with large branches down nearly to the ground. Individual trees attain great size when growing under favorable circumstances. Although the living tree may exude a great deal of gum, the wood is quite free from resin. It is straight-grained, light, soft, and pliable. Because of these qualities, it has been in great demand for airplane building.

Description.—Tall symmetrical tree 75 to 180 feet high, the older trees with slender side branchlets hanging down from the main branches; bark deep reddish-brown, thin, often scaling off in large flakes; foliage yellowish-green; leaves stiff, flat, rather thick, keenly pointed, standing out straight all around the branches; cones about 2 to 4 inches long, becoming lustrous straw-colored to reddish-brown, hanging from the branchlets; cone scales thin and resilient, enclosing small winged seeds.

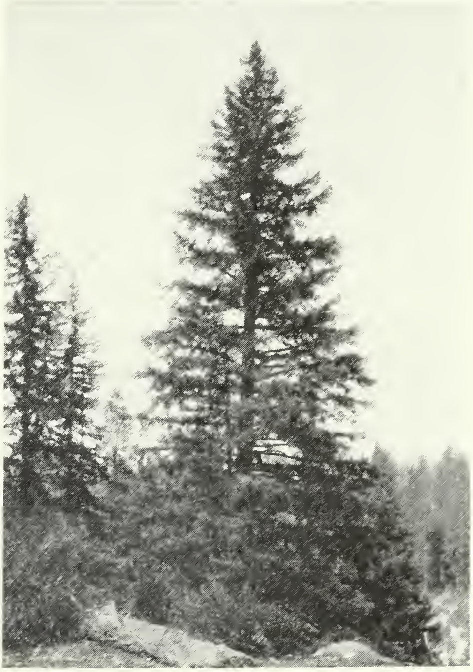

FIGURE 42.—Douglas fir. Crater Lake National Park.

Occurrence.—Olympic, common at low elevations on the west side: Hoh River; Olympus guard station. Mount Rainier, rare: Near Carbon River Ranger Station; North Puyallup River near western boundary.

Douglas Fir (*Pseudotsuga taxifolia* (Lamb) Britt.)

Douglas fir attains its best development in the Northwest where it is one of the most abundant trees, growing to be the largest and most conspicuous tree in the lowland areas in Mount Rainier and Olympic National Parks. The larger trees usually have broken storm-beaten tops and rough, buff-colored bark which marks the tree from either above or below. Some of the largest specimens in the park are estimated to be nearly a thousand years old. The species is sometimes called Douglas spruce because of its resemblance to the spruces. From this it differs in having soft needles and a peculiar 3-pointed tongue protruding from beneath each cone scale, thus giving the cone a fringed or lacy appearance (figs. 42 and 43). In many respects it resembles the firs because of the flat, blunt needles, but differs in that the needles are attached to the branchlets by more slender stems. They tend to go completely around the stem instead of spreading horizontally or turning upward. Also, in Douglas fir, the cones hang down from the branchlets, while in the firs they are borne upright and only towards the top of the tree.

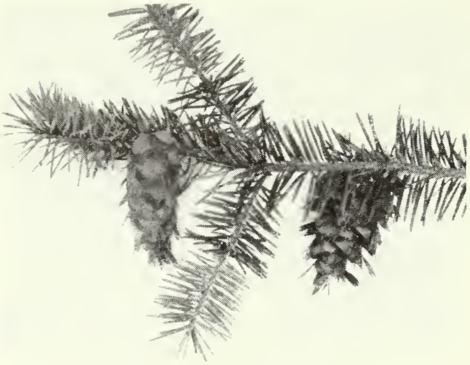

Figure 43.—Douglas fir cones.

Douglas Fir as a Forest Type

This species extends along the slopes of the Cascade and Sierra Nevada Mountains, becoming decreasingly abundant as one proceeds southward, until at Yosemite National Park it is comparatively rare, occurring only in small stands on the sides of the Merced and Hetch Hetchy canyons. The species is entirely lacking in Sequoia National Park.

In the Southwest region Douglas fir occurs only in shaded sites where sufficient moisture is obtainable for growth. At Mesa Verde National Park a few patches occur at the north end of the park and in Spruce Canyon, which erroneously received its name from two small stands of "Douglas spruce" which occur in the canyon. At Grand Canyon National Park it occurs usually with white fir but occasionally small pure stands are found on north-facing slopes. The trees are small in this region as compared to those found in the Pacific Northwest but under favorable conditions of shade and moisture specimens may occasionally reach 100 feet in height and several inches in diameter.

Douglas fir is a common species at intermediate elevations in the Rocky Mountain region. In the valleys it may become a sizable tree, but on the more exposed slopes, where it is most common, it is small and often much deformed. The type covers extensive areas at Glacier National Park where it occurs in greatest abundance on the west side of the Continental Divide either in pure stands or in association with western larch. It is as important a component in the forested areas in this park as it is at Mount

Rainier National Park, but the trees are smaller and the stands much more open. At Grand Teton and Yellowstone National Parks the tree prefers the rocky southern exposures at intermediate and high elevations. At Rocky Mountain National Park it occurs in association with ponderosa pine at lower elevations, continuing on up as high as the spruce-fir belt.

Description.—Crown at first pyramidal and sharp pointed, later becoming broad and rounded, the lower branches and the slender side branches usually long and drooping; trunk massive, covered with dark brown, broadly ridged and deeply furrowed bark; foliage deep yellow-green; cones light brown, 2 to 3 inches long, with long, thin, 3-pointed tongues protruding from between the cone scales.

Occurrence.—Olympic, abundant up to about 2,500 feet: Lake Crescent; Elwha River; Hoh River; North Fork Quinault River; Duckabush River; Dosewallips River. Mount Rainier, abundant, 1,700 to 5,000 feet: Entrances to the park at lower elevations. Crater Lake, rare, 4,000 to 6,000 feet: Annie Creek road; Crescent Ridge; North Fork Castle Creek. Lassen, present. Yosemite, occasional, 4,000 to 7,000 feet: Canyon walls of Hetch Hetchy and Yosemite Valleys; near Mirror Lake; Bridal Veil Falls; Glacier Point; Chinquapin. Glacier, common on rocky slopes, 3,600 to 6,500 feet: Sprague Creek camp ground; Lake McDonald Hotel; Logan Pass Road; Nyack drainage; Harrison Lake; Coal Creek; Bowman Lake; Quartz Lake. Yellowstone, occasional: Mammoth; Tower Falls; Tower Junction; 3 miles from east entrance; along Cache Creek. Grand Teton, common, 6,500 to 9,000 feet: Mouth of Death Canyon. Rocky Mountain, common in canyons, 9,000 to 10,000 feet. Mesa Verde, occasional, 6,800 to 8,200 feet: Found on north-facing slopes in Spruce Canyon just below park headquarters and along Rim Drive. Bryce, common, 7,500 to 9,000 feet: Near Fairyland in the central part of the park; Union Pacific Spring; Navajo Trail. Zion, rare, above 6,500 feet: Draw west of Red Arch Mountain; Echo Canyon; West Rim Trail near ranger cabin. Grand Canyon 5,700 to 8,800 feet: North Rim, common: Kaibab Plateau. South Rim, occasional just below rim.

Hemlock (*Tsuga* Carr.)

Western hemlock is the most common tree at low elevations in Mount Rainier and Olympic National Parks. At the lower elevations it is associated with Douglas fir and western red cedar; at intermediate elevations, with silver fir. It occurs rarely at high elevations with alpine fir and whitebark pine. Because of its tolerance to shade and its longevity, it eventually replaces other species with which it is associated excepting the western red cedar which is a codominant. A few scattered trees of western hemlock occur on the west side of Glacier National Park.

Mountain hemlock is more widespread in the parks than western hemlock, occurring along the Pacific Slope as far south as Yosemite National Park. At Mount Rainier and Olympic National Parks the windswept, dense-foliaged branches make the tree easily distinguished, even at a distance, from the spire-shaped alpine fir. Unlike the alpine fir, which often becomes dwarfed and matted at timberline, the mountain hemlock more often withstands the heavy snows and winds in an upright position. At Crater Lake National Park the tree covers large areas composing about a quarter of the forested area. At Lassen Volcanic National Park the mountain hemlock stands are common at high elevations, occurring most frequently either in pure stands or with red fir. At Yosemite National Park mountain hemlock and western white pine are the most common high elevational trees and along with lodgepole pine, compose most of the eastern three-quarters of the park.

Western Hemlock (*Tsuga heterophylla* (Raf.) Sarg.).—This tree is found in moist forests of the Pacific Northwest where it occurs in pure stands or more often in association with Douglas fir, true firs, or other trees of the same vegetation belt. Its best growth is attained where the annual precipitation is not less than 70 inches. Because of its great tolerance to shade, and because the tree bears an abundance of seed, seedlings and young trees are often abundant even in the very dense forests. Western hemlock is usually easily distinguished from the firs, spruces, and the Douglas fir by the nodding leader, drooping branches, and the open, "lacy" foliage.

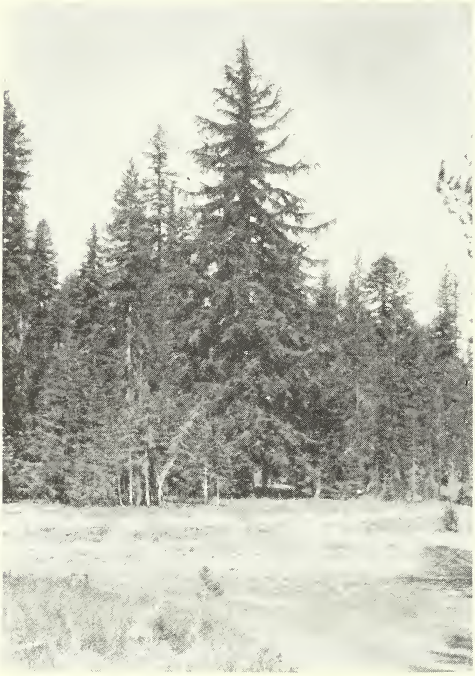

Figure 44.—Mountain hemlock. Crater Lake National Park.

Description.—A large, graceful tree with slender, drooping branches unequal in length, forming a narrow, open crown; bark of older trees tinged with red, 1 to 1½ inches thick and deeply furrowed; foliage glossy, deep yellow-green, appearing thin because of the small size of the leaves; leaves flat with rounded ends, whitish on the underside, appearing to grow mainly from two opposite sides of the stem; cones about 1 inch long with thin red-brown scales maturing in one season, borne singly more or less generally over the crown, wood yellow-brown, fine-grained, rather light and soft.

Occurrence.—Olympic, abundant, up to 3,500 feet: Elwha River; Quinault River; Duckabush River; Dosewallips River. Mount Rainier, abundant, 1,400 to 5,000 feet: North Puyallup River; Longmire; Ohanapecosh Hot Springs; White River entrance; Carbon River ranger cabin. Glacier, limited to a few areas on the west side: Avalanche campground; Lake McDonald Hotel; Sprague Creek campground, Crater Lake.

Mountain Hemlock (*Tsuga mertensiana* (Bong.) Sarg.) (fig. 44).—This hemlock grows at higher elevations than does the western hemlock. It may form pure, open groves but is most conspicuous along with alpine fir in the high country. The heavily-foliaged branches sweeping gracefully towards the ground make this tree one of the most picturesque of any in the parks. It is distinguished by its dense crown, broad at the base but narrowing abruptly above to the slender, nodding, whiplike leader. The slender, small cones often occur in such dense clusters that they bear the branchlets down with their weight. One would think that the dense foliage would be an excellent shelter for rain, but this is not the case. The drooping branches slant inwards toward the trunk so that water is carried inward. Thus the tree offers little protection from showers.

Description.—A tall, slender tree terminated by a graceful, nodding, whiplike leader; branches often touching the ground when growing in open locations; bark dark reddish-brown or dull purplish, deeply furrowed in old trees, scaly in the younger; leaves bluish-green, flat and blunt, about ½ to 1 inch long, closely set all around the branchlets, but appearing thicker on the upper sides; cones about 1½ to 2 inches long, slender, about ½ to ¾ inch wide before opening, borne near the top of the tree, at first a bluish-purple to a yellow-green, becoming a dull brown when open; wood fine-grained, soft, lighter in weight than that of the western hemlock.

Occurrence.—Olympic, abundant, 3,000 to 6,000 feet: Constance Ridge; Hayden Pass; Low Divide; Martins Park; Seattle Creek Trail; Glacier Meadows; Bogachiel Peak. Mount Rainier, abundant, 4,500 to 6,500 feet: Grand Park; Yakima Park; Paradise Valley; Shriner Peak; Tipsoo Lake. Crater Lake, abundant, 4,500 to 7,000 feet: Cloudcap Peak; Wizard Island; Mount Scott; crater rim. Lassen, common, 6,000 to 9,600 feet: Lassen Peak; Diamond Peak; Hat Mountain; Summit Lake; north of Reflection Lake. Yosemite, common, 7,500 to 11,000 feet: Meadow below Mount Clark; Tenaya Lake; near Cathedral Lake; Ahwahnee Hotel.

Pine (*Pinus L.*)

There are 13 species of pine in the western national parks, with one or more species present in each of the parks. Lodgepole pine covers the largest total area of any coniferous forest type but ponderosa pine has a wider distribution. This latter species is common in the parks except those of the Pacific Northwest, while lodgepole pine is entirely absent from the parks of the Southwest. Yosemite and Sequoia National Parks each have 9 pines, 7 of which are common to both areas.

Distribution of Forest Types

Sugar pine type.—Sugar pine occurs as a forest type only in the California parks, although a few scattered trees also occur at Crater Lake National Park in Oregon. It is the only one of the white pines which does not range at high elevations. This pine is much more common in other types than it is as a dominant tree. The largest sugar pine forests are found at Sequoia and Yosemite National Parks.

Western white pine type.—This pine is limited to our Pacific slope parks and to the west side of Glacier National Park. It is especially important at Yosemite National Park where it covers some 23,000 acres, but it also is of some importance at Lassen Volcanic and Mount Rainier National Parks, occupying about 5,000 acres in each of these two parks. It is found occasionally in pure stands, but is more commonly associated with other trees such as with red fir in the parks of California, and with mountain hemlock, Douglas fir, and alpine fir in the Cascade parks and at Glacier National Park. This species occurs extensively in other dominant coniferous types, but the trees are often only very sparsely scattered and are not recorded on the forest maps.

Limber pine type.—This pine is recorded as a type only in our northern and southern Rocky Mountain parks, although scattered trees occur also in Yellowstone and Grand Teton National Parks. Nearly 15,000 acres are covered by the type at Glacier National Park and 9,000 acres at Rocky Mountain National Park. A small stand also occurs in Kern Canyon, at Sequoia National Park.

Whitebark pine type.—This species, occurring in eight national parks, is the most widespread of the high elevational pines. It covers the most extensive areas at and just below timber line, particularly in Yellowstone, Glacier, and Yosemite National Parks. The largest areas occur at Yellowstone National Park where it makes up more than 72,000 acres of the forested area. Many thousands of acres also are found in Glacier National Park, but at Rocky Mountain National Park in the southern part of the Rocky Mountain region limber pine replaces the whitebark pines. At Mount Rainier National Park the latter replaces mountain hemlock as the common associate of alpine fir in the subalpine forest around Yakima Park, but it is otherwise not abundant. At Crater Lake and Lassen Volcanic National Parks whitebark pine occurs only at the highest elevations, frequently in association with mountain hemlock but the type does not cover extensive areas in either park. At Sequoia National Park, whitebark pine favors semibarren areas at or near timber line. At Yosemite National Park it is particularly abundant, being the most common white pine in the park.

Foxtail pine type.—This tree is limited to two sections of California, i. e., in the southern Sierra Nevada and in the coast ranges in the northwest part of the State. It occurs primarily in pure stands at high elevations in the Kern River drainage in Sequoia National Park where it forms the largest coniferous type in the park.

Ponderosa and Jeffrey pine types.—Ponderosa pine, also called western yellow pine, is found in abundance in the southern parks, but is rare or lacking in most of the northern parks. Jeffrey pine, also a yellow pine, is found only in the California parks, and occurs in the vegetation belt above that occupied by ponderosa pine. Here it occupies even more extensive areas than does the ponderosa pine type. At Yosemite and Sequoia National Parks both species of yellow pine occur, but Jeffrey pine is much the more common. The largest areas of this species occur at Yosemite National Park.

In the Rocky Mountain region ponderosa pine is rare or lacking except at Rocky Mountain National Park where it forms an important type in some areas at low and intermediate elevations. Throughout the Southwest region, with the exception of Mesa Verde National Park, ponderosa pine is the most important conifer. It occupies extensive areas at Grand Canyon National Park, covering more than 57,000 acres. In each of these parks it forms the predominant cover on the higher plateaus. The stands are usually open and parklike, but in some cases they may have a shrubby undercover or may be almost wholly semibarren.

Lodgepole pine type.—Though lodgepole pine is a short-lived tree and is particularly susceptible to insect damage, it covers the largest areas and forms the largest type of any species in the parks. Commonness of its occurrence, particularly in the Rocky Mountains, is due to the fact that it is a fire type and among the first species of tree to enter burned-over areas. It adapts itself to a wide variety of soil, moisture, and climatic conditions. Extensive stands of lodgepole pine also occur in the California parks but the type is lacking in the Pacific Northwest and in the Southwest parks except at Mount Rainier National Park. Here a few scattered trees cover relatively little area and are of interest principally because of the irregular distribution. The species is common on the rather poor rocky soil in the vicinity of the White River campground, and isolated specimens are occasionally found in outlying situations, such as on the divide between Mystic Lake and Moraine Park at 6,000 feet. It is also found about the meadows at Longmire (2,760 feet) although in this case it is very likely that these trees originated from introduced seed.[6]

At Crater Lake National Park this is the most common tree in the park, occurring either in pure stands on the flats at lower elevations or, less commonly, mixed with mountain hemlock or Shasta fir at higher elevations. Large areas of lodgepole pine have been killed by insect attack so that dead snags constitute a considerable portion of the type in certain parts of the park. At Lassen Volcanic National Park lodgepole pine is one of the most common pines, especially on the northern and eastern sides of the park. It occurs mostly in pure stands, but occasionally is associated with red or white fir. At Yosemite National Park lodgepole pine covers the most extensive areas of any conifer, making up more than a quarter of the forested area. The eastern three-quarters of the park is largely covered by three coniferous types—lodgepole pine, mountain hemlock, and western white pine. Here, as at Crater Lake National Park, extensive areas have also been killed by insect infestation. At Sequoia National Park lodgepole pine is common at relatively high elevations, particularly along streams and around mountain meadows, not infrequently occurring near timber line in the subalpine type.

In the Rocky Mountain parks, lodgepole pine covers the most extensive areas of any tree type. At Glacier National Park it occurs at low and intermediate elevations, most commonly in pure stands or occasionally mixed with Engelmann spruce, western larch, and Douglas fir. At Yellowstone National Park the type covers about one and a third million acres or nearly three-quarters of the park area. At Grand Teton National Park this species, while covering extensive areas at lower elevations on the slopes bordering Jackson Hole, is not found at high elevations, nor is it the most common tree type as is the case in other parks of this region. The type occurs typically in pure stands with little or no undercover. At Rocky Mountain National Park the lodgepole pine type occupies a belt reaching from lower elevations up to about 9,500 feet. The trees are mostly small, usually under 60 feet in height and a foot in diameter. Approximately three-quarters of the type occurs in pure stands and the remainder in mixed stands with aspen or Engelmann spruce.

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[6] Brockman, Frank, Forests of Mount Rainier National Park, Nature Notes, 1939. Mimeographed.

Piñon-juniper type.—This type occurs only in the parks of the Southwest where it forms more than a quarter of the forested areas. It is composed predominantly of piñon and Utah juniper, although single-leaf piñon and Rocky Mountain red cedar may occasionally occur in the type. At Bryce Canyon National Park the type occurs principally on the eastern side of the plateau and less commonly on the hot dry canyon slopes. Here the trees are dwarfed and usually scattered. At Grand Canyon National Park the piñon-juniper forest is the chief component of the forest on the South Rim and covers extensive areas on the exposed canyon slopes just below the North Rim. The type is open and frequently has a shrubby ground cover. Rocky Mountain red cedar occurs quite frequently in the type, especially on the North Rim. At Mesa Verde National Park the piñon-juniper type is the dominant cover on the plateau in the southern half of the park and also on the canyon walls. At Zion National Park the talus slopes of the canyon are largely covered with piñon-juniper and scrub oak types and not infrequently fair sized stands occur at higher elevations on the plateau.

Field Guide to the Species of Pines

I. Five needles to a bundle.
  A. Trees having long cones hanging down from near the ends of the branches.
    1. Cones 1 to 1½feet long; found only in the California parks . . . 1. *Sugar pine.*
    2. Cones ⅓ to 1 foot long.
      (a) Found on the Pacific slope and at Glacier National Park on the west side; cones long-stalked, pendulous . . . . 2. *Western white pine.*
      (b) Found in the Rocky Mountain region and at Sequoia National Park; cones very short-stalked, spreading . . . . 3. *Limber pine.*
  B. Trees with roundish to oblong cones; needles short and rigid, often somewhat curved; high altitude trees.
    1. Cone scales without prickles; cones roundish or egg shaped; found in Rocky Mountain and Pacific coast parks . . . . 4. *Whitebark pine.*
    2. Cone scales with prickles.
      (a) Prickles on the cone scales tiny; found at Sequoia National Park . . . . 5. *Foxtail pine*
      (b) Prickles on the cone scales long and slender; found at Bryce Canyon National Park . . . . 6. *Bristlecone pine.*
II. Three needles to a bundle (occasionally two).
  A. Cones remaining closed and attached to the branches for many years; found only rarely at Yosemite National Park . . . . 7. *Knobcone pine.*

B. Cones opening at maturity and not remaining on the branches.
    1. Trees with yellow-green foliage; found at middle elevations.
        (a) Cones ovoid, 3 to 6 inches long; bark scales sulphur-yellow on the under side . . . . 8. *Ponderosa pine.*
        (b) Cones oval, 5 to 11 inches long; bark scales appearing brownish-red on under side when stripped from the trunk; found only in California parks . . . . 9. *Jeffrey pine.*
    2. Trees with bluish green foliage; found only at lower elevations in Yosemite National Park . . . . 10. *Digger pine.*

III. Two needles to a bundle (see also ponderosa pine).
    A. Species found in all the parks except those of the Southwest; cones with small seeds . . . . 11. *Lodgepole pine.*
    B. Species found in the Southwest only; cones with large seeds . . . . 12. *Piñon.*

IV. One needle to a bundle; found in the Southwest, rarely at Yosemite and Sequoia National Parks . . . . 13. *Singleleaf piñon.*

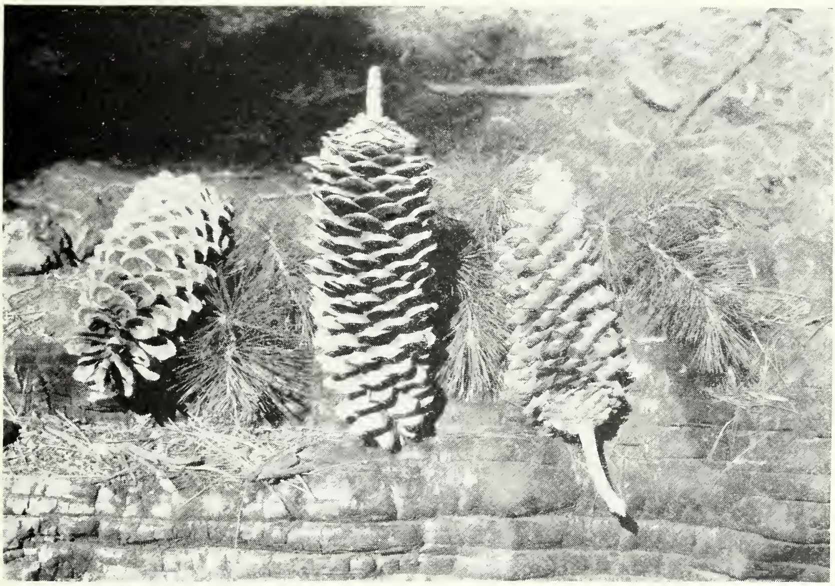

FIGURE 45.—Sugar pine.

1. **Sugar pine** (*Pinus lambertiana* Dougl.) (fig. 45).—The sugar pine is the largest and most magnificent of all western pines. The huge branches standing out at right angles from the trunk and the long cones hanging from the tips of the branches serve to distinguish the tree at a long distance. The common name is derived from the sugary resin which is exuded when the bark is wounded. This substance is said to have been collected and eaten as a delicacy by the Indians. Squirrels, as well as humans, are fond of the large pine nuts. The cones, the longest of any found in the parks, are often collected by travellers to be used for interior decorations. It is said that Douglas, the first white man to collect specimens of sugar pine, was so enthralled by the magnificent cones, that, in order to obtain specimens, he shot them down from the tree. The noise attracted Indians who, for-

tunately, proved friendly. The pitch of this tree was used by the Indians to repair canoes and to fasten the arrowheads and feathers to the shafts. The dry resin was powdered and used in the treatment of sores and ulcers.

Description.—An open tree with huge horizontal arm-like branches; bark reddish-brown, flaking off in peculiar shaped figures suggesting the parts of a jigsaw puzzle; foliage a deep bluish-green with a whitish tinge, congested towards the ends of the branches; needles 5 in a bundle, about 3 to 4 inches long; cones cylindric, 12 to 22 inches long, hanging singly or in twos or threes from the tips of the upper branches.

Occurrence.—Crater Lake, occasional at the lowest elevations on the south and west sides of the park. Lassen, occasional, 5,350 to 6,350 feet: Above Kelly Camp; east side of King's Creek; near Anklin Meadows. Yosemite, abundant, 3,000 to 7,500 feet: Mariposa, Merced and Tuolumne groves of Big Trees; Glacier Point; Sentinel Dome; Carl Inn; Little Yosemite; near top of Yosemite Falls Trail. Sequoia, abundant, 5,000 to 9,700 feet: Sunset Rock, Giant Forest area; Moro Rock.

2. **Western white pine** (*Pinus monticola* Dougl.).—This attractive tree is sometimes called the little sugar pine because of its close resemblance to the sugar pine of California and Oregon. The needles, though usually shorter and more blunt, are in clusters of five and the long cones suggest small sugar pine cones (fig. 46). In dense forests its branches are usually short and slender, but in the open the trees often have several long, stout, horizontal branches extending 10 to 15 feet or more beyond the other more slender branches. This striking character distinguishes the tree from as far as it can be seen. This species is very susceptible to white pine blister rust, a fungus disease which has as an alternate host species of gooseberry and currant. The disease has done serious damage to the western white pines, particularly in Mount Rainier National Park. Control work is being done here and in many other park areas.

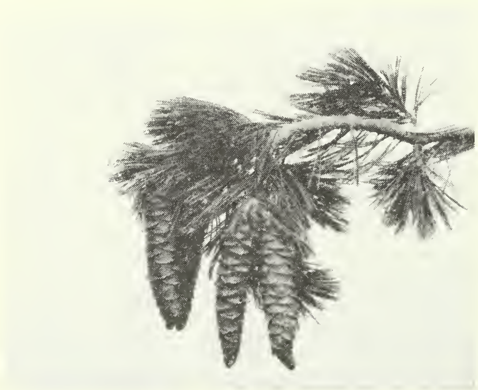

FIGURE 46.—Western white pine cones.

Description.—Young trees tall, slender, beautifully symmetrical; branches usually slender and drooping; bark thin, grayish to reddish-brown, broken into innumerable squarish plates; foliage bluish-green with a whitish tinge; needles in clusters of 5, about 1 to 4 inches long; cones brown, long and slender, about 5 to 10 inches long, hanging from the ends of the branches, often with several in a group.

Occurrence.—Olympic, common, up to 5,000 feet; Lake Crescent; Elwha River; Mount Appleton. Mount Rainier, common, 3,000 to 5,000 feet: Longmire; Stevens Canyon. Crater Lake, common, 5,500 to 7,000 feet: Wizard Island; Kerr Valley. Lassen, rare, 6,000 to 8,250 feet: North side of Hat Mountain; near Reflection Lake. Yosemite, common, 6,600 to 10,000 feet: Below Vernal Falls; Merced Lake; Clouds Rest; Piute Mountain; trail to Tenaya Lake; near Sentinel Dome. Sequoia, common, 7,500 to 10,500 feet: Heather Lake; Emerald Lake; Alta Peak Trail. Glacier, occasional on the west side, 3,500 to 4,200 feet: Avalanche Lake; McDonald Valley; Lake McDonald Hotel.

3. **Limber pine** (*Pinus flexilis* James) (fig. 47).—It is said that limber pine was so named because of its flexible branchlets which may almost be tied in knots without breaking. This is true also of whitebark pine with which limber pine is often confused. The mature limber pine has dark furrowed bark, while that of whitebark pine is usually smooth and white. The oblong cones of the limber pine bear a close resemblance to those of western white pine while those of whitebark pine are egg-shaped and have a distinct purple color. The flexible branchlets well adapt the tree to the windswept ridges and slopes on which it generally occurs. At higher elevations it is much reduced in size and is often shrub-like.

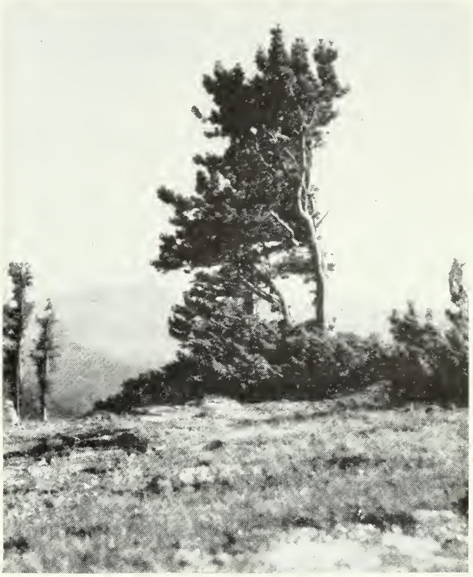

Figure 47.—Limber pine. Rocky Mountain National Park.

Description.—Same as that of whitebark pine except as noted above.

Occurrence.—Sequoia, rare, 9,500 to 12,000 feet: On the plateau near the mouth of Whitney Creek. Glacier, common and widespread on the east side of the Continental Divide, 4,500 to 9,000 feet: Above Waterton Lake; Goat Haunt Mountain; near Morning Eagle Falls. Yellowstone, occasional: Mammoth Hot Springs. Grand Teton, rare, 8,000 to 9,500 feet: Ridge north of Phelps Lake. Rocky Mountain, common, 9,000 to 12,000 feet: Near Crags Hotel; along Fall River Road; lower south and east slopes of Mount Dickinson; Mount Tileston; Bighorn Mountain; Meadow Mountain.

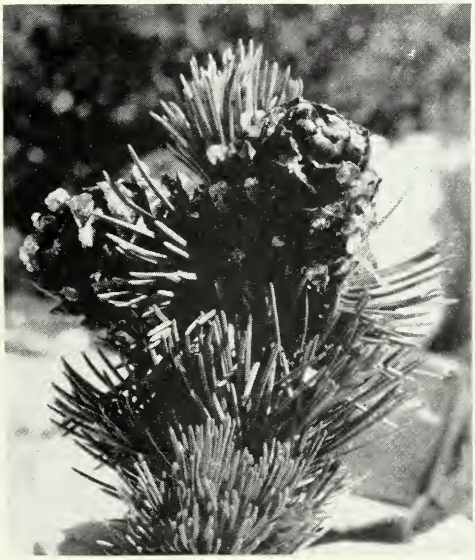

Figure 48.—Whitebark pine.

4. **Whitebark pine** (*Pinus albicaulis* Engelm.).—On the Pacific slope whitebark pine is found along the crest of the Cascades and in the Sierra Nevada at high elevations. In the Rocky Mountain parks it extends as far south as Grand Teton National Park. Whitebark pine is typically a timber line tree found mainly on ex-

posed slopes and ridges where the trees are often battered by the wind and very much dwarfed or with twisted or contorted trunks. However, in Grand Teton National Park several unusually large trees occur, some of them attaining a height of 80 feet with trunks sometimes more than 3 feet in diameter. Whitebark pine is very susceptible to the white pine blister rust.

Description.—Usually a small scrubby tree, 15 to 40 feet high, with a trunk diameter of 10 to 24 inches; bark smooth, thin, whitish; needles dark yellow-green, stout, often somewhat curved, 1 to 2 inches long, in bundles of 5, clustered towards the ends of the branches; cones egg-shaped or roundish, 1 to 3½ inches long, purplish, usually remaining closed for several years (fig. 48).

Occurrence.—Olympic, rare: Head of Kneer Creek at base of Wellesley Peak; ridge between Dosewallips River and head of Greywolf River. Mount Rainier, common, 5,500 to 6,500 feet: Throughout park at higher elevations; Yakima Park. Crater Lake, occasional, 7,500 to 8,900 feet; Mount Scott; Wizard Island. Lassen, occasional, 7,250 to 10,000 feet: Eagle Peak; Mount Lassen. Yosemite, common, 9,200 to 12,000 feet: A narrow belt on higher peaks at and just below timber line; Falls Ridge; Mount Dana; Mount Lyell; Mount Clark; Sunrise Ridge between Cathedral Lakes and Little Yosemite; Vogelsang Pass, Sequoia, occasional 10,500 to 12,000 feet: Common on Great Western Divide at timber line; head of Kern Canyon; Mount Whitney; north of Army Pass; Mount Langley. Glacier, common on west side, 5,500 to 9,000 feet: Trail to Grinnell Glacier; above Harrison Lake; Dawson Pass; Surprise Pass. Yellowstone, occasional, 7,000 feet to timber line: Dunraven Pass; east entrance road; Sylvan Pass. Grand Teton, abundant throughout the park, 6,500 to 10,750 feet: South Fork Cascade Canyon near junction of the forks.

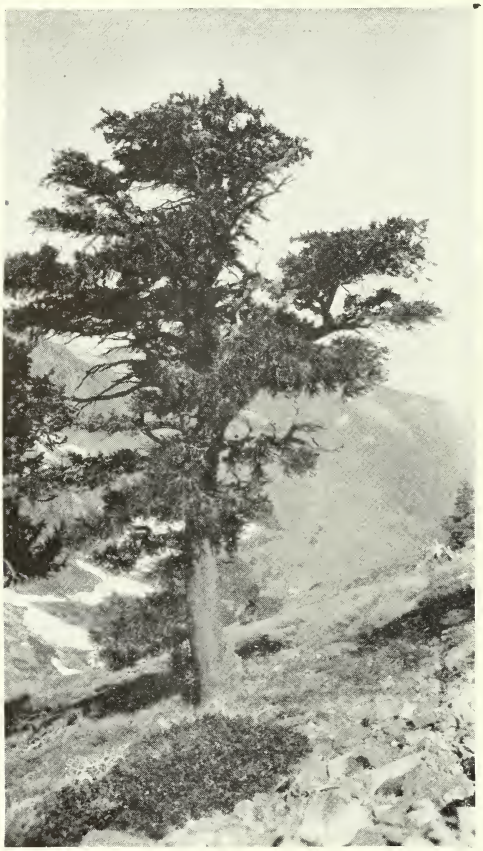

FIGURE 49.—Foxtail pine. Sequoia National Park.

5. **Foxtail pine** (*Pinus balfouriana* Murr.) (fig. 49).—Foxtail pine, so called because of the bushy tail-like arrangement of the leaves at the ends of the branches, generally grows in small groups at or near timber line. In the Kern River drainage of Sequoia National Park it composes the principal forest cover. Trees even near timber line grow upright and the trunks may attain a surprising diameter, sometimes up to 3 feet. Some specimens

must be centuries old. Grouse find its branches a hospitable roosting place during the winter and frequently eat the young buds. The trunks of fallen trees are often hollowed out by rot and furnish convenient shelter for wildlife.

Description.—Tree 20 to 45 feet high, with a narrow, bushy crown; bark smooth, reddish-brown; branches stout, the bright blue-green foliage thickly clothing the half-drooping branchlets; needles in 5's, ¾ to 1½ inches long, curved; cones slender, russet-brown, 2½ to 5 inches long.

Occurrence.—Sequoia, common, 7,500 to 12,000 feet: Kern Canyon; Big Arroyo; Alta Meadows.

6. **Bristlecone pine** (*Pinus aristata* Engelm.).—This pine is found in several of the western states but is very rare in the national parks. It is known to occur in a few isolated spots in Bryce Canyon National Park (fig. 50). The cones are of special interest because of the slender, bristle-like prickle at the tip of each cone scale. Because of the shape and hardness of the cone the tree is also called hickory pine.

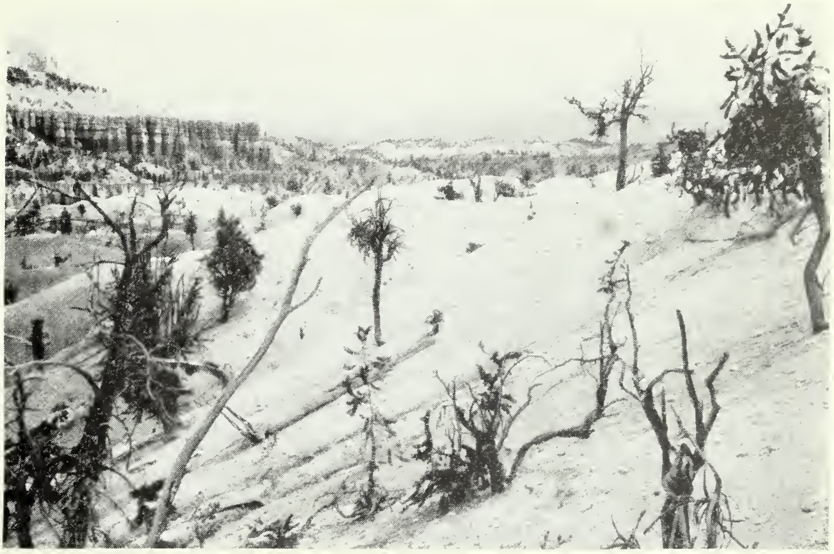

FIGURE 50.—Bristlecone pine is one of the few trees that gains a foothold on hot, dry slopes at Bryce Canyon National Park.

Description.—Tree 15 to 30 feet high, with a wide bushy crown; upper branches long and upright, the lower shorter and drooping; needles 1 to 1½ inches long, in bundles of 5, closely clustered at the ends of the branches; cones 2½ to 3½ inches long, deep purplish-brown, the end of each cone scale tipped with a fragile bristle.

Occurrence.—Bryce Canyon, occasional, 7,500 to 9,000 feet: North slope of Mormon Temple; east peak of Rainbow Mountain; Inspiration Point; Mud Canyon; Swamp Canyon.

7. **Knobcone Pine** (*Pinus attenuata* Lemmon).—Knobcone pine is characterized by the circles of knoblike cones occurring at intervals around the

branches, main stems, and even on the trunks of small trees. The cones remain on the trees year after year without opening to shed the seed, hence it belongs to the closed cone group. The species, like the lodgepole pine, quickly reseeds an area after a forest fire passes through. The heat causes the cones to open. Knobcone pine is found in the parks only in Yosemite National Park where but a few specimens occur.

Description.—Tree 10 to 30 feet high, with open crown, the branches appearing to grow in circles along the main trunk; needles in groups of 3, usually 3 to 5 inches long; cones narrowly egg-shaped, pointed and somewhat curved toward the tip, 3 to 6 inches long, occurring in circles around the branches and persisting for indefinite periods; cone scales somewhat thickened at the tips and raised into rounded or pointed knobs.

Occurrence.—Yosemite, rare, 2,000 to 3,500 feet: Near El Portal; near Chinquapin.

8. **Ponderosa pine** (*Pinus ponderosa* Dougl.) (fig. 51).—Ponderosa pine, so called because of its large "ponderous" size, is one of the most widespread trees in the western national parks. It seems well able to adapt itself to the great variety of habitats and to the great range of temperature and precipitation in the different localities in which it occurs. The tree is usually found in open groves with little or no undercover. Along "ponderosa way" in the Sierra Nevada, one may travel day after day in the ponderosa pine forest. The needles occur typically in groups of three, but the species at Rocky Mountain National Park is peculiar in being a two-needle form (fig. 52) which is sometimes mistaken for lodgepole pine. Ponderosa pine is one of the most important lumber trees of the West.

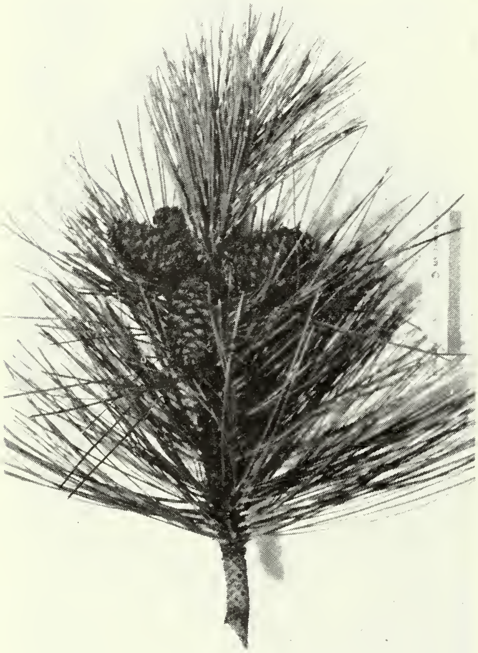

Figure 51.—Ponderosa pine.

Description.—Large, straight-trunked tree, 60 to 200 feet high, with a trunk 2 to 6 feet in diameter; bark thick, yellowish-brown, that of older trunks reddish and composed of large, scaly plates; the scales covered underneath with a yellow powder; young twigs, when crushed, with strong characteristic odor; foliage borne in heavy brushlike clusters at the ends of the branches, deep yellow-green; needles in three's (or two's), 3 to 10 inches long; cones reddish-brown, narrowly egg-shaped, 3 to 6 inches long, the scales tipped with a prickle; seeds small, about ¼ inch long, with a thin wing.

Occurrence.—Olympic, rare: Lake Crescent. Mount Rainier, very rare: Small tree found near Cascade Crest at head of Cougar Creek; another, ½ mile west of Double Peak, 5,000 feet; another above Yakima Park Road. Crater Lake, occasional at lower elevations, 4,500 to 5,500 feet: Southeast corner of park; Annie Creek Road. Yosemite abundant, 3,200 to 6,000 feet: Yosemite Valley; Ahwahnee Hotel; Hetch Hetchy Valley. Sequoia, abundant, 4,400 to 6,500 feet: Sunset Rock, Giant Forest area; near Colony Mill ranger station. Glacier, rare, 3,500 feet: North Fork of Flathead River. Rocky Mountain, common, 7,000 to 9,000 feet: Lower foothills and valleys: Estes Park. Mesa Verde, rare, 8,300 feet: Morefield Well; Prater Canyon. Bryce, abundant, 7,000 to 9,000 feet: Northwest side of park; north entrance checking station; park headquarters. Zion, abundant, 5,100 to 7,500 feet: Widespread over the plateau country; Zion-Mount Carmel Highway. Grand Canyon, abundant, 5,500 to 9,000 feet: North Rim checking station; Kaibab Plateau; around the villages on both rims.

9. **Jeffrey pine** (*Pinus jeffreyi* Murr.) (fig. 53).—Jeffrey pine is a magnificent forest tree very similar in appearance to the ponderosa pine, but usually occurring at higher elevations. Where the two are found growing in the same vicinity, one may easily be mistaken for the other. The cones of the Jeffrey pine are much larger and heavier and the bark darker. If a scale is lifted from the trunk of Jeffrey pine, it will appear smooth and reddish on the inside but a piece stripped from the trunk of ponderosa pine will be found to be covered with a yellow powder. Probably it is for this reason that it is also called yellow pine. That there is a distinct difference between the two species is shown by the fact that certain pine beetles attack the Jeffrey but not the ponderosa pine.

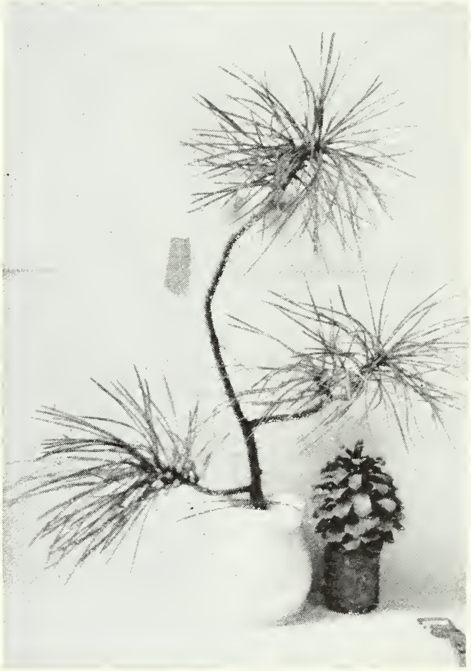

Figure 52.—Two-needle form of ponderosa pine.

Description.—Same as for ponderosa pine except as noted above.

Occurrence.—Lassen, abundant, 5,100 to 7,300 feet: North slope of Lassen Peak; Kelly Camp; Manzanita Lake checking station. Yosemite, 6,000 to 9,200 feet: Rim of Yosemite Valley; Yosemite Creek. Sequoia, abundant, 5,500 to 11,000 feet: Sunset Rock, Giant Forest area; Lodgepole Camp; High Sierra Trail; Atwell Mill; Kern River Canyon; west of Little Baldy.

10. **Digger pine** (*Pinus sabiniana* Dougl.).—This is a rare tree in the parks (found only at the lower limits of Yosemite National Park), although it is common in the Sierra Nevada foothills below the western boundaries of the California parks. The name Digger pine comes from the Digger Indians who used the pine nuts for food. The cones are large and heavy and pro-

duce very hard seeds. The rather sparse-looking foliage has a grayish-green cast and the trunk is widely branching from near the base, quite in contrast to the yellow-green foliage of the ponderosa pine and its straight main stem.

Description.—Usually widely branched tree, 40 to 80 feet high; bark dark gray, roughly furrowed; leaves 6 to 13 inches long, 3 in a bundle; cones more or less egg-shaped, 6 to 10 inches long, the cone scales with thick sharp points which are often hooked; seeds large, about ¾ inch long, with very hard-shelled seeds.

Occurrence.—Yosemite, rare, 1,400 to 4,000 feet: Near El Portal; Hetch Hetchy; Tuolumne River up to Tiltill Valley.

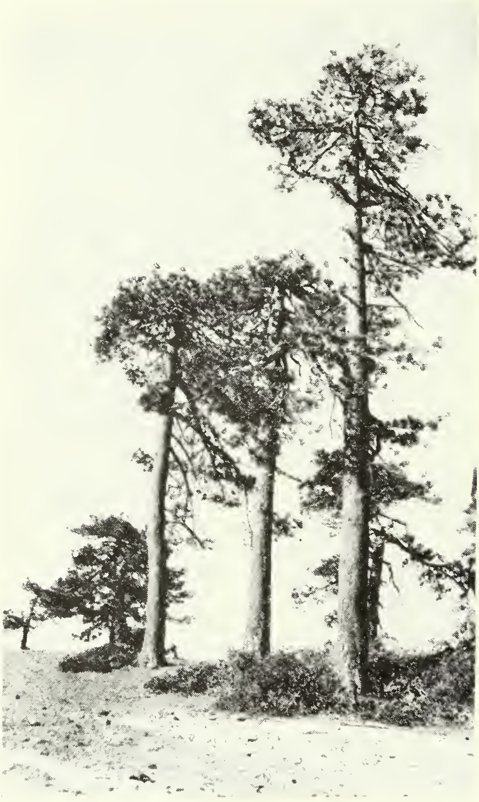
FIGURE 53.—Jeffrey pine. Yosemite National Park.

11. **Lodgepole pine** (*Pinus contorta* Dougl.) (fig. 54).—Lodgepole pine is the most widely distributed and probably the most variable forest tree in the parks. It is the principal forest tree in the Rocky Mountains, where it occurs in dense stands with tall, clean, slender trunks. On the Pacific slope it commonly occurs at relatively high elevations. Here the tree usually has a more open crown, often with the branches extending all the way down the trunk. The cones are small and adhere to the branches for a great many years. While some open each year to shed their seeds, many remain closed for indefinite periods or until a forest fire passes through and the heat causes the cones to open. When the seeds fall on bare soil under favorable conditions, they germinate readily and the seedlings grow rapidly, often forming dense thickets in burned-over areas. The Sierra Nevada and Rocky Mountain form of lodgepole pine has been distinguished by many botanists as variety *Murrayana*, but since the species is so variable in whatever region it grows and no distinctions can be found in the cones [7], the layman may better consider all forms as the same species.

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[7] Sudworth, G. B., Forest trees of the Pacific Slope, p. 49: U. S. Dept. Agr., Forest Service, 1908.

Description.—Tree 15 to 100 feet high with a trunk 6 to 30 inches in diameter; needles yellowish-green, 1 to 3 inches long, usually 2 in a bundle, densely clothing the branchlets; cones brown, ¾ to 2½ inches long, egg-shaped, each scale tipped with a slender prickle, remaining attached to the tree many years after maturing.

Occurrence.—Olympic, occasional: Trail to Dose Meadow above Hayes River Guard Station. Mount Rainier, occasional, 4,000 to 6,000 feet: White River camp ground; Mystic Lake. Crater Lake, abundant, 4,500 to 8,500 feet: Widespread throughout the park. Lassen, common, 5,500 to 10,000 feet: Lassen Peak; Hat Creek; Chaos Lava Beds. Yosemite, common, 4,900 to 10,000 feet: Widespread throughout the park; Yosemite Valley; near Wawona; Mount Dana; Mount Gibbs. Sequoia, common, 6,500 to 11,500 feet: Widespread throughout the park below timber line; Lodgepole Camp; Alta Meadows; Hockett Meadows; ridge between Cliff Creek and Deer Canyon. Glacier, abundant, 3,500 to 6,500 feet: Belly River; Waterton Lake; Many Glacier; Kintla Lake area; Bowman Lake. Yellowstone, abundant: East entrance; Sylvan Pass; Gibbon River; Firehole River. Grand Teton, abundant and widespread at low elevations, 6,500 to 7,600 feet: Near Jenny Lake campgrounds; northeast of Phelps Lake along trail to Death Canyon. Rocky Mountain, abundant and widespread at lower elevations throughout the park. 8,500 to 11,000 feet: Near Horseshoe Park; Trail Ridge Road.

12. **Piñon** (*Pinus edulis* Engelm.) (fig. 55).—The piñon, together with Utah juniper, forms much of the forest cover in the southwestern parks and monuments. The piñon-juniper forest is especially fine at Mesa Verde National Park where, viewed from a promontory, it suggests a heavy, olive-green carpet, interrupted only now and then by small patches of sagebrush or grassland. The piñon pine has long been considered a very important source of timber, fuel, and food by the Indians of the Southwest. For centuries they have collected and stored the pine nuts for winter food. The pitch is sometimes used even now as an adhesive for water-proofing vessels and as an antiseptic for wounds.

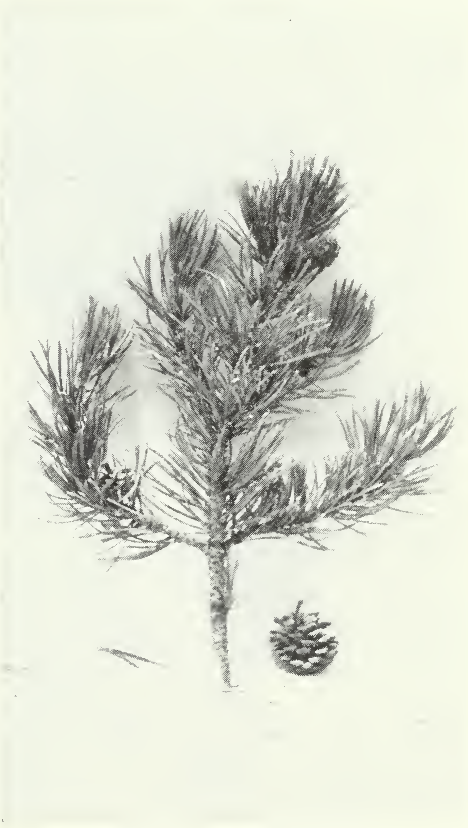
FIGURE 54.—Lodgepole pine.

Description.—A low, round-topped tree, 18 to 40 feet tall, branching from or near the base; foliage olive-green, often with a grayish tinge; needles in 2's, rather stiff, 1 to 2 inches long; cones small, usually egg-shaped, covered with globules of pitch; seeds large, wingless when they fall from the cones.

Occurrence.—Mesa Verde, abundant, 6,800 to 8,000 feet: Widespread over the plateau. Bryce, common, 6,600 to 8,000 feet: Widespread in the eastern part of the park; Glory Cove; Campbell Cliffs; Shakespeare Point. Zion, common, 4,500 to 7,000 feet: On talus in the canyons and in the southwest quarter of the park. Grand Canyon, 5,000 to 8,000 feet: North Rim, common on the slopes below the rim. South Rim, the dominant tree.

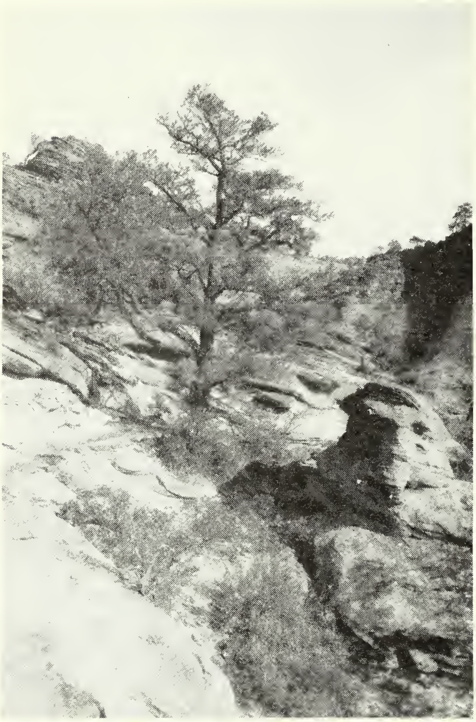

Figure 55.—Piñon pine. Zion National Park.

13. **Singleleaf piñon** (*Pinus monophylla* Torr.).—This tree is unique amongst all other American pines in having a single needle to a "bundle" instead of having 2, 3, or 5. It is found in a few places in Yosemite and Sequoia National Parks but is more common in the Southwest where it is often confused with the 2-needle piñon because of the similarity in color and form. It is from these trees that the pine nuts of commerce are obtained. The green cones (fig. 56) are gathered in large quantities and piled in heaps. Then with the aid of heat from a slow fire they are gradually dried out until they burst open and shed their seeds.

Description.—A low tree 15 to 20 feet high, chunky and solid, mature trees much branched all the way down the trunk; bark dark brown, roughly furrowed; needles borne singly, pale yellow-green with a whitish tinge, about 1 to 2 inches long, stiff, sharp pointed, curved toward the branch; cones oval or somewhat globose, 2 to 3 inches in diameter, dark reddish-brown or yellow; cone scales with a pyramid-like point at the end which soon falls off; seeds large, wingless when they fall from the cones.

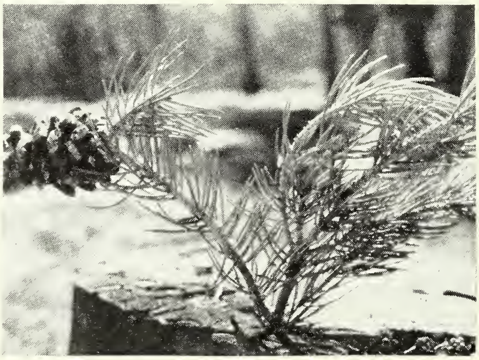

Figure 56.—Singleleaf piñon.

Occurrence.—Yosemite, rare: Near Rancheria Falls on Tiltill Trail, ½ mile north of Le Conte Point, 6,100 feet; Pate Valley, 5,500 feet. Sequoia, rare, 6,650 to 8,800 feet: Near upper Funston Meadows; west wall of Kern Canyon at Chagoopa Bridge; upper Tocopah Valley. Bryce, rare. Zion, occasional, 4,000 to 6,000 feet: Near south entrance; along trail from Zion Lodge to Birch Creek; slopes above the Lodge. Grand Canyon, rare: Nankoweap Basin; Bright Angel Canyon near power house.

Larch (*Larix* Adans)

Glacier National Park has the distinction of being the only western national park (except Mount McKinley) having larch, and here there are two species present. The larches are among the most distinctive trees found in northern forests. The needles occur in clusters on short woody pegs on the branches as in the cultivated ornamental cedars, but the crown is more open and the foliage thinner. The trees lose all their leaves each fall. This is a characteristic not found in any other cone-bearing tree native to the western United States. The bright yellow color of the dying needles makes this tree easily distinguished in late autumn.

As a forest type western larch occurs only on the west side of the Continental Divide, while alpine larch occurs on either side.

Western larch (*Larix occidentalis* Nutt.).—This larch, because of its thick basal layer of bark, is one of the few trees having a high resistance to fire. In the burned areas around Belton and Lake McDonald the western larch has withstood the fires better than any other species, and so is now common in the formerly burned areas. Also it re-seeds promptly after a fire, forming dense, sometimes almost impenetrable thickets.

Description.—A fine tree often 100 feet or more in height, with a straight tapering trunk and an open crown; bark reddish brown, thick and deeply furrowed near the base, but thinner and smoother above; branches horizontal, small, and comparatively few; needles about 1 to 2 inches long, 20 to 30 in brushlike bundles on woody pegs, pale yellowish green, becoming yellow in late fall; cones light brown, 1 to 1½ inches long, the scales papery, with long slender, tongue-like bracts protruding from between them.

Occurrence.—Glacier, common, 3,000 to 6,400 feet: Belton; Lake McDonald; Sperry Chalets; Kintla Lake; Logging Lake; Nyack Lake area; Park Creek area.

Alpine larch (*Larix lyallii* Parl.).—This is much smaller than the western larch, often having a stunted appearance because of its timberline growth. The branches are long and large and are tougher than those of western larch. This is an important factor in its ability to withstand the adverse conditions at timber line where this tree occurs. "Woolly larch" is a name sometimes given to alpine larch because of a fine coating of white wool on the new branch shoots and on the cones.

Description.—Trees usually 30 to 40 feet in height, often with bent or crooked trunks; bark a deep purplish or reddish brown, or ashy gray in young trees, less than 1 inch thick, with irregular flat ridges; foliage a light bluish green, turning bright lemon yellow in late fall; needles in brushlike bundles, ¾ to 1½ inches long; cones about 1½ to 2 inches long with bristly, slender, purple tongues projecting from beneath the cone scales; cone scales deep purple red with a fringe of tangled, fine white wool on their margins.

Occurrence.—Glacier, occasional, 6,800 to 8,500 feet: Logging Mountain; north side of Logging Lake.

Field Guide to the Cedars and Junipers

I. Trees with cones; foliage flattened (cedars).
  A. Found only in the California and Oregon parks; cones oblong, composed of a few thin cone scales..1. *Incense cedar.*

B. Found in the Northwest.
  1. Tree of the lower elevations; cones composed of several thinnish overlapping scales . . . . 2. *Western red cedar.*
  2. Tree of the higher elevations; cones small, round, the cone scales umbrella-like and attached to a common center . . . . 3. *Alaska cedar.*

II. Trees with dryish berries; foliage cord-like (junipers).
 A. Found in parks of the Southwest and Rocky Mountains.
  1. Foliage rather coarse, yellowish-green; occurs in the Southwest . . . . 4. *Utah juniper.*
  2. Foliage finer, dark green; occurs in the Southwest and Rocky Mountains . . . . 5. *Rocky Mountain red cedar.*
 B. Found only in California parks . . . . 6. *Western juniper.*

1. **Incense cedar** (*Libocedrus decurrens* Torr.) (fig. 57).—Incense cedar, found only in the California parks and at Crater Lake National Park, resembles the young Big Trees in many respects. Both have reddish fibrous bark and dark green foliage, but at close range one could scarcely be mistaken for the other. The incense cedar leaves are scale-like on flattened branchlets, while those of the Big Tree are stiff, sharp-pointed and awl-shaped on cordlike branchlets. Unlike the giant Sequoia, incense cedar is not found in groves, but occurs only as scattered individuals usually among ponderosa pine, sugar pine, and white fir. The wood has little value because of the prevalence of rot in the older trees. A decoction of the leaves is said to have been used by the Indians for stomach trouble.

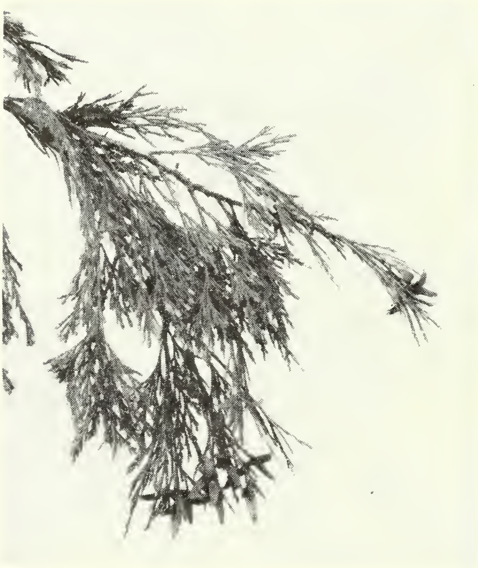

FIGURE 57.—Incense cedar.

Description.—Young trees with dense, narrow, pointed crowns, the branches extending almost to the ground; older trees with open, irregular crowns; bark reddish or cinnamon brown, somewhat fibrous, deeply furrowed, 2 to 3 inches thick; foliage light yellow green; branchlets flattened and arranged in one plane, forming flat, drooping sprays; leaves small, scalelike, with long bases extending down the branchlets; cones brown, oblong, about 1 inch long, hanging down from the branchlets, composed of three pairs of scales, when open appearing to have only three scales, the two sides spreading from the middle and resembling somewhat the fluer-de-lis emblem; seeds winged, two to four in each cone.

Occurrence.—Crater Lake, rare, about 4,600 feet: Below old park boundary, near Fort Klamath. Lassen, present, up to 7,500 feet: North slopes of Lassen Peak; southeast corner of the park. Yosemite, common in the ponderosa pine belt, 3,300 to 7,200 feet: Hetch Hetchy Valley; near Yosemite Falls; Ahwahnee Hotel; road from Yosemite Valley to Wawona. Sequoia, common, 3,800 to 7,500 feet: Clough Cave; Giant Forest; Atwell Mill; Kern River Canyon near park boundary.

2. **Western red cedar** (*Thuja plicata* D. Don).—Western red cedar is found only in the Northwest where it becomes one of the finest trees in the areas in which it grows, often approximating the huge size of the Douglas fir. It occurs abundantly at lower elevations in moist locations at Mount Rainier and fine stands occur also in Glacier National Park near the head of Lake McDonald. Western red cedar seldom occurs in pure stands, but is associated with Douglas fir or western hemlock. This tree is easily recognized by the scalelike leaves and the spreading fanlike sprays of branches. Western red cedar most closely resembles Alaska cedar which occurs at Mount Rainier, but in the latter the branches are more drooping and the foliage more lacy in appearance. Even so, it is sometimes hard for the visitor to distinguish between them unless cones of both are at hand. In Alaska cedar the cone-scales are attached to a common center while in western red cedar the cones are composed of thinner overlapping scales and resemble more nearly those of western hemlock.

Description.—A large tree with dense, yellow-green aromatic foliage and drooping branches spreading at the ends in fanlike sprays; leaves scalelike, entirely clothing the branchlets; cones small, borne near the ends of the branchlets on the lower as well as the upper part of the tree; scales thin, few; wood soft, reddish, very durable.

Occurrence.—Olympic, common at lower elevations: Elwha River at Godkin Creek. Mount Rainier, common, 2,000 to 3,500 feet: Longmire; Carbon River Road near Cataract Creek; Ohanapecosh Hot Springs. Glacier, common, especially on the west side, 3,000 to 4,200 feet: Lake McDonald Hotel; McDonald Creek; Avalanche campground; Sprague Creek campground.

3. **Alaska Cedar** (*Chamaecyparis nootkatensis* (Lamb) Spach).—This tree is found along the coast in Alaska, Canada, and in the northwestern United States, often occurring in small pure stands on exposed mountain sides. In general appearance it resembles the western red cedar, but occupies a higher life zone. The distinguishing characters for these two species are given in the discussion of western red cedar, but since their ranges seldom overlap, there is usually little difficulty in distinguishing between the two. The bark of Alaska cedar is exceedingly thin and affords little protection against fire, hence the trees rarely survive a serious forest fire. At Mount Rainier National Park a large number of these trees have been killed by fire in the area just below Yakima Park, but the whitened snags are still standing and mark what is known as the "silver" or "ghost" forest. This fact attests to the remarkable durability of the wood even when exposed to weathering. It is still possible to get usable timber from the "silver forest" although the trees have been dead for many years.

Description.—A graceful tree with a narrow, open crown, nodding top, and drooping branches; bark thin, fibrous, reddish-brown, weathering to a pearl gray in exposed sites; foliage yellow-green; leaves small, scalelike, closely covering the branchlets in four rows; cones small, round, deep russet-brown, with only a few scales attached on the center "core"; wood very fine-grained, sulphur yellow in color.

Occurrence.—Olympic, common: Seven Lakes Basin, 5,000 feet; Martins Park above Low Divide, 4,500 feet. Mount Rainier, common, 3,500 to 6,000 feet: Trail to Pinnacle Peak; Paradise Valley; Yakima Park.

4. **Utah juniper** (*Juniperus utahensis* (Engelm.) Lemmon) (fig. 58b).—Utah juniper is an important constituent of the forest cover in the parks of the Southwest. The tree is similar in appearance to the bushy form of the Rocky Mountain red cedar which is extensively used as an ornamental, but the branchlets are thicker and more rigid. The berries are a reddish-brown covered with a whitish powder. They were credited with mystic powers by the Navajos and also used to some extent for food by small mammals. Deer occasionally utilize the foliage as winter forage. The bark and wood, which have remarkably durable qualities, were extensively used for building purposes and remnants hundreds of years old may still be seen in the cliff dwellings today. In many parts of the Southwest the tree is very susceptible to the attack of mistletoe.

Description.—A bushy tree with a short trunk, or the trunk branching above the ground; crown rather open, composed of many upright branches; trunk bark thin, grayish-brown, sometimes flaking into long, thinnish scales, that of the larger twigs pale reddish-brown; foliage dense, yellowish-green; leaves small, scalelike, sharp-pointed, in opposite pairs and closely overlapping each other in four rows; berries smooth, reddish-brown, covered with a white waxy powder, usually containing one seed (occasionally two).

One-seeded juniper (*Juniperus monosperma* Sarg.), usually with dark blue berries, occurs with Utah juniper in Mesa Verde National Park, but it is very difficult to distinguish between the two species.

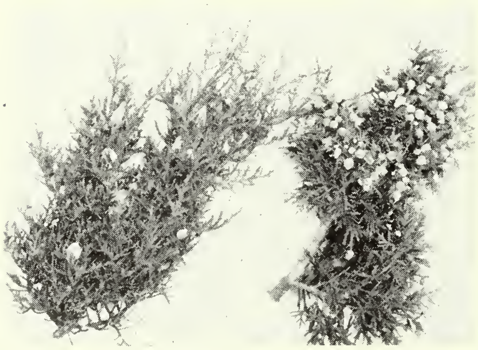

FIGURE 58.—*a*, Rocky Mountain red cedar; *b*, Utah juniper.

Occurrence.—Mesa Verde, common, 6,800 to 8,000 feet: Around park headquarters; north entrance. Bryce, present. Zion, common, 4,000 to 5,500 feet: On the steep talus slopes of the canyons. Grand Canyon, 4,700 to 8,400 feet: North Rim, occasional. South Rim, abundant: Nankoweap Basin; Great Thumb; Coconino Plateau. Canyon, abundant on the upper walls of the canyon below both rims.

5. **Rocky Mountain red cedar** (*Juniperus scopulorum* Sarg.) (fig. 58a).—This species is found scattered throughout the Rocky Mountains. The trees are seldom found in large numbers but occur in the national parks as single individuals or in small groups scattered among piñon pine and Utah juniper. It is often columnar in form, with long branches nearly to the base of the short trunk when found in the open on dry exposed mesas and mountain slopes, while in sheltered canyons it has a single straight trunk and slender crown with the ends of the branches drooping or pendent. For this reason it is called "weeping juniper" in some areas. The foliage is utilized to some extent for food by deer during the winter months when other forage is scarce. Many birds and small mammals are fond of the berries.

Description.—Tree with bushy crown, 15 to 20 feet high in open situations; taller and more slender, with graceful drooping branches, in sheltered canyons; bark reddish-brown or grayish, somewhat stringy; foliage dark green with a whitish cast due to a fine film of white powder covering the leaves; leaves scalelike, often long-pointed, in opposite overlapping pairs densely covering the slender branchlets; mature berries smooth, bluish due to a white wax covering the blackish skin, usually containing two seeds; wood dull red, fine grained, and durable.

Occurrence.—Glacier, occasional, 4,000 to 5,500 feet: On rocky banks at Belton; near North Fork Flathead River. Yellowstone, common up to 6,000 feet: Hot Springs formations at Mammoth; along road entering Mammoth from Tower Falls. Rocky Mountain, occasional at low elevations. Mesa Verde, rare, about 6,500 feet: Around Park Headquarters; Spring Canyon; canyon below Cliff Palace. Bryce, common, 7,000 to 8,000 feet: Near Shakespeare Point and south; Glory Cove; Campbell Cliffs. Zion, common, 4,600 to 7,500 feet: West Rim plateau; around park headquarters; near the east entrance. Grand Canyon, rare on the North Rim, about 7,500 feet: At the extremities of points and promontories along the edge of the rim.

6. **Western juniper** (*Juniperus occidentalis* Hook.).—Western juniper, ranges throughout the Sierra Nevada, particularly in the high country. It is usually a low, round-topped, short-trunked tree, often weather-beaten and gnarled. The enormously long and large roots help this tree to withstand the fierce winds on the rocky, exposed slopes which it seems to prefer. The Indians are said to have used the pitch from this tree to fasten feathers to arrow shafts and also to have rubbed pitch into the shafts to make them tougher.

Description.—Small tree usually about 15 to 20 feet high, with a rounded crown extending nearly to the ground; bark ridged, shreddy, a light cinnamon brown; branches relatively large, standing out stiffly from the trunk or tending upward; foliage ashy-green; leaves scalelike, in circles of three, closely overlapping each other on cordlike branchlets; fruit a berry about ⅓ inch in diameter, bluish-black, covered with a whitish powder.

Occurrence.—Yosemite, common, 5,600 to 10,500 feet: Glacier Point; from Nevada Falls and Eagle Peak to Mount Conness and Mount Ritter; southwest of Moraine Mountain; east of Benson Pass on Smedberg Lake Trail; near junction of Clark and Gray Creeks. Sequoia, common, 7,000 to 11,000 feet: Along the side walls of Kern Canyon.

Big Tree (*Sequoia gigantea* (Lindl.) Dec.) (fig. 59).—Big Tree is undoubtedly the most interesting tree in our national parks. It is confined to the west slope of the Sierra Nevada, occurring in well-defined groves varying in number from a few to several thousand trees. Giant Forest is the largest of 70 groves which are found in the 250-mile-range in which the species occurs. The trees are invariably associated with white fir or sugar pine and usually occur at elevations between 5,000 and 7,500 feet, although they have been found to occur under unusual circumstances at elevations as low as 3,000 feet and as high as 8,800 feet.

The Big Tree is said to have been discovered first by white men in 1839 when an entry concerning it was made in the Journal of the Joseph R. Walker exploration party.[8] However, specimens were not collected until 1852 when the Calaveras Grove was discovered by a hunter in pursuit of a grizzly. The name, *Sequoia*, was chosen in 1847 by Endlicher, a German

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[8] Been, Frank, The Sequoias: Sequoia National Park. Mimeographed report.

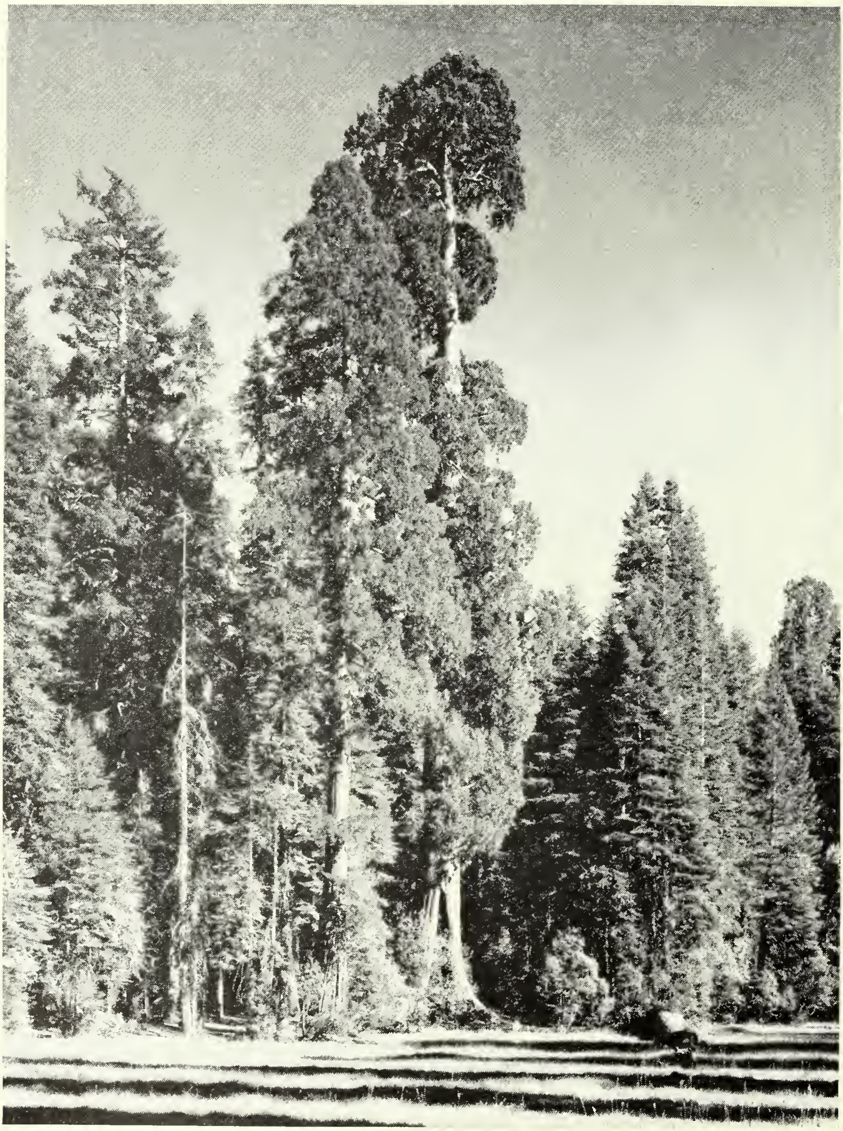

FIGURE 59.—The rounded top is typical of the Big Tree. Sequoia National Park.

botanist, in honor of a Cherokee Indian, Sequoyah, who invented an alphabet for his tribe. But this was before botanists had become aware of the existence of the Big Tree. The name was applied to the coast redwood which had previously been considered a species of the bald cypress, *Taxodium*. In 1854 the Big Tree was named *Sequoia gigantea*. Prior to that it had been called *Wellingtonia gigantea* and *Taxodium giganteum*, and there is still some controversy as to whether the name should be *Sequoia gigantea*. *S. Wellingtoniana* or *S. Washingtoniana*.

The Big Tree and the coast redwood are survivors of a race which was at one time the predominating tree in the Northern Hemisphere. During the ice age the Sequoias became more and more restricted in range until they now occupy their present very limited range in California and are generally considered by the foresters to be decadent species. The foliage of the Big Tree differs from that of the coast redwood in having short sharp-pointed awl-shaped leaves all around the stem instead of the longer fir-like leaves spreading from the stem to form flat sprays. The cones (fig. 60) are larger and heavier than those of the coast redwood, being about the size of an egg. They are at first a bright green, later turning a rich red brown. Even though each cone produces 200 to 300 seeds, there are very few seedlings because comparatively few of the seeds are fertile and they require bare soil to germinate. The dark blue-green foliage of the Big Tree can be confused with no other Sierra tree, although at a distance the habit of the young Big Tree resembles somewhat the incense cedar.

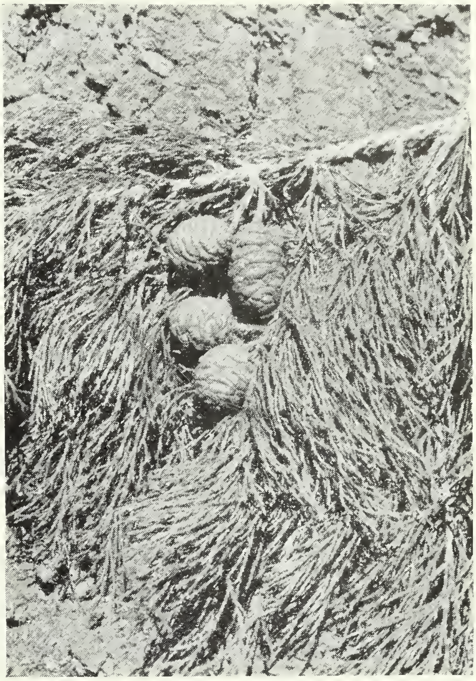

Figure 60.—Big Tree cones.

The root system is shallow, seldom penetrating much more than 6 feet but usually spreading laterally 200 to 300 feet. The trunk is deeply fissured, giving the tree the appearance of an immense fluted column. The lower bark at the base of the tree is much thicker than that higher up on the trunk and may attain a thickness of nearly 2 feet, although it is usually much less. The thick, fibrous fire-resistant bark acts as an insulation against heat and accounts perhaps more than any other factor for the many old giants which are still standing despite large fire scars. Also, both the bark and the non-resinous heartwood resist the ravages of insects, probably because of the high tannin content.

Description.—A very large tree 100 to 325 feet high with a trunk 5 to 30 feet in diameter; crown dense and sharp-pointed when young, later becoming round-topped and, in age, irregular and broken; bark red-brown, somewhat fibrous, deeply furrowed or fluted, ½ to 2 feet thick; foliage deep blue-green, in drooping sprays; leaves short, awl-shaped, sharp-pointed, overlapping each other on the branchlets; cones egg-shaped, 1½ to 3 inches long.

Occurrence.—Yosemite, 3 groves: Mariposa Grove; Tuolumne Grove; Merced Grove. Sequoia, 30 groves, 6,000 to 7,500 feet: Giant Forest Grove; Garfield Grove; Atwell Grove; Dillon Wood Grove; Eden Grove; East Fork Grove; Redwood Meadow Grove; Castle Rock Groves; South Fork Grove; Muir Grove; Paradise Ridge Grove; Homer's Nose Grove; Case Mountain Grove; Redwood Creek Grove; Pine Ridge Grove. The remaining groves embrace less than 100 acres each.

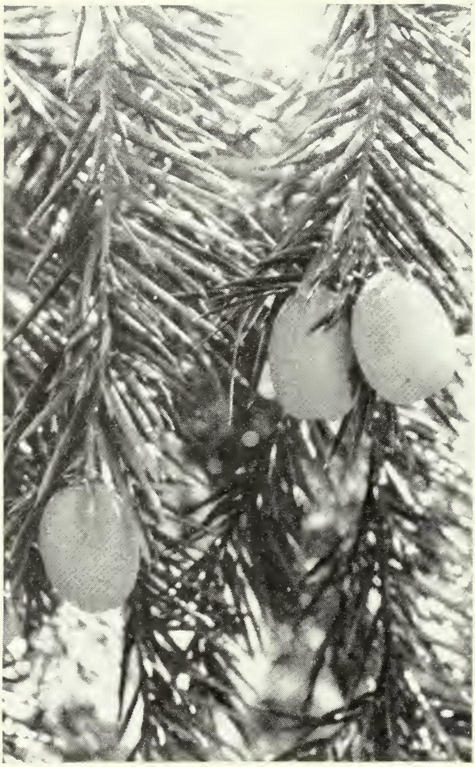

FIGURE 61.—California nutmeg.

California nutmeg.—(*Tumion californicum* Torr.) (fig. 61).—California nutmeg is one of the few needle-bearing forest trees which do not bear cones. It has a peculiar plumlike fruit, which seems out of place with the sharp-pointed needlelike leaves. The name, California nutmeg, comes from the fancied resemblance of its seed kernel to the nutmeg of commerce. Locally it is known as stinking cedar because of the disagreeable odor emitted when its green bark, leaves, and branchlets are crushed. This tree is found only in California. In Sequoia and Yosemite National Parks it favors cool, shaded canyons where it may form dense thickets. It grows in pure stands or mixed with canyon live oak and other species.

Description.—A rather small tree, 15 to 50 feet in height, with an open crown; branches standing out horizontally from the trunk and drooping towards the ends; bark rather soft, with finely checked seams, green on the younger branches, becoming an ashy yellowish brown; leaves flat, rigid, sharply pointed; fruit oval or egg-shaped, about 1 to

1½ inches long, with thin resinous flesh and a large hard seed, green at first, or, when ripe, streaked with purple.

Occurrence.—Lassen, present. Yosemite, rare: Near junction of Merced River and Cascade Creek and down the Merced River as far as Arch Rock. Sequoia, rare, 2,500 to 6,000 feet: Above Clough Cave; Cliff Grove of Big Trees; north of Moro Rock.

Western yew (*Taxus brevifolia* Nutt.).—Western yew is widespread in the mountains of the Pacific slope as far south as Sequoia National Park. It is typically an undercover species in Douglas fir forests of the Northwest, being remarkably tolerant of shade. In the parks it seldom grows to tree size, but is more often a many-stemmed shrub. However, in Mount Rainier and Olympic National Parks some specimens have been found with a trunk diameter of 8 or 9 inches. The wood, which is tough and heavy and very fine and close-grained, is the best obtainable for bows and was used for such by the Indians. An interesting bit of legend is connected with the yew wood. It is said that the English law once required that for every cask of wine brought in from Spain, "yew wood enough for two goodly bows" must accompany the cask as import duty. This tree is unique among the evergreen forest trees in that it bears bright red berries instead of cones. These are often eaten by birds and chipmunks.

Description.—A many-stemmed shrub or a small tree 10 to 40 feet tall, the branchlets unequal and somewhat drooping, giving the crown a weeping effect; bark smooth, dark reddish brown, thin and scaly; foliage deep yellow-green; leaves flat, pointed at the ends but not bristly, and shiny on the upper surface, pale below; male and female flowers borne on separate trees; fruit fleshy, bright scarlet, with a single hard seed inside.

Occurrence.—Olympic; Above Olympic Hot Springs. Mount Rainier, abundant, up to about 4,000 feet: North Puyallup River Road. Crater Lake, present. Yosemite, occasional. Sequoia, occasional. Glacier, common 3,100 to 5,500 feet Avalanche campground.

Woodland Type

The woodland type, occurring principally along streams and on moist slopes and flats, is composed of species of broadleaf trees. Comparatively few of the broadleaf species occurring in the national parks form dominate types. At Mount Rainier National Park the woodland type, occurring predominantly along streams, covers less than 200 acres. Red alder is the common dominant, but mountain alder is also abundant along the higher mountain streams, generally occurring as a shrub rather than as a tree. Scattered trees of bigleaf maple are occasionally found in the lower forests, but these are not confined to streams and only occasionally form a part of the woodland type. At Crater Lake National Park the woodland type covers only a few acres and is composed principally of two species of trees. A few patches of black cottonwood occur along the south entrance road of the park and an area of aspen occurs at the Pinnacles. At Lassen Volcanic National Park the type is small and is composed predominantly of aspen and, less commonly, willow. At both Yosemite and Sequoia National Parks there are two different kinds of woodland. In the lower parts of the park where the major part of the woodland type occurs, canyon live oak predominates. It covers the ridges and canyon sides often in association with other species of oak. At higher elevations aspen with a ground cover of grass and herbaceous species predominate. California sycamore and white alder are found along the margins of streams but cover comparatively little area in the park.

In the Rocky Mountain region, the woodland type is composed predominantly of aspen which occurs on moist flats and along the margins of lakes and streams. In dry sites it may become shrublike in stature. Its prevalence in this region may be explained by the fact that it is often among the first tree species to enter burned-over areas. The cottony seed, which it produces in great quantities, is easily transported by the wind and is thus well adapted to re-seed denuded areas. At Glacier National Park the woodland type is composed predominantly of aspen. Balsam poplar occurs at lower elevations in canyon bottoms and along the margin of lakes and streams, and makes up about a sixth of the type. Paper birch also occurs in the type in similar sites. At Yellowstone National Park, aspen is the only common broadleaf tree in the park. It covers more than 12,000 acres, occurring in greatest abundance at the northern end of the park in thickets or groves.

At Grand Teton National Park, as in the other Rocky Mountain parks, aspen is the dominant species in the type and is often associated with willow and snowbrush. At lower elevations the aspen often occurs in groves, sometimes with narrowleaf cottonwood, but at high elevations it is usually shrubby, often forming dense thickets. Balsam poplar becomes the largest broadleaf tree in the park, but it is not common, for it occurs only in moist canyon bottoms. At Rocky Mountain National Park aspen is the only common woodland species and occurs most commonly in pure stands. The tree is found scattered in many forest types at lower elevations, often in association with such conifers as lodgepole pine.

In the Southwest region at Grand Canyon National Park, the most extensive areas of woodland occur on the North Rim and are made up primarily of aspen in pure stands. In the canyon itself the woodland type, occurring primarily along streams, is composed of such broadleaf trees as Fremont poplar associated with various species of willow. At Zion National Park the woodland type is made up predominantly of the same species of broadleaf trees and less commonly boxelder. The type occurs predominantly along the Virgin River. At higher elevations on the plateau, particularly in the northern part of the park, the aspen type is found. At Bryce Canyon National Park the type covers a little more than 100 acres and occurs predominantly on north-facing slopes or in canyon bottoms. The woodland type is lacking at Mesa Verde National Park except for a few small patches of aspen which occur at the north end of the park.

Field Guide to the Broadleaf Trees

I. Leaves palmate, that is, the main veins join at a common point at the end of the leaf-stem. Leaf may be divided into three to five broad teeth or into separate leaflets.
  A. Leaves alternate with each other; flowers and fruits in round greenish or brown balls borne along a slender stem; found at Sequoia National Park. CALIFORNIA SYCAMORE, p. 106.
  B. Leaves opposite, that is, paired along the stem.
    1. Leaves not divided into smaller leaves (leaflets); seeds in winged pairs; found in some of the Pacific slope parks.................... BIGLEAF MAPLE, p. 106
    2. Leaves completely divided into three to five smaller leaves (leaflets).
      (a) Leaflets three or five, irregularly jagged-toothed; seeds in winged pairs; found in the Southwest parks...................... BOX ELDER, p. 107.
      (b) Leaflets five, finely toothed; fruit a large dark brown seed inclosed in a leathery pod, 1 to 2 inches in diameter; found in Yosemite and Sequoia National Parks.......................... CALIFORNIA BUCKEYE, p. 107.

II. Trees with leaves divided into several opposite pairs of smaller leaflets.
  A. Leaves alternate, that is, one at a stem-joint; stems usually thorny; flowers showy, pea-like; fruits long pods; found only in the Southwest.
    1. Leaves divided twice into many very small leaflets; flowers yellow; pods constricted between the seeds..........................MESQUITE, p. 108
    2. Leaves divided only once into smaller leaflets; flowers pink or white; pods not constricted between the seeds...........................LOCUST, p. 108.
  B. Leaves opposite each other; fruits winged seeds, borne in clusters..ASH, p. 109.

III. Trees with leaves simple (neither palmate nor divided into opposite pairs).
  A. Trees having flowers with petals or petallike bracts; found only on the Pacific slope.
    1. Petals yellow; flowers borne in compact clusters; leaves dark, shiny green, with a strong aromatic odor....................CALIFORNIA LAUREL, p. 110.
    2. Petals (or bracts) white.
      (a) Flowers borne in heads surrounded by 4 to 6 large white petallike bracts, 2 to 3 inches across; fruits red, berrylike..PACIFIC DOGWOOD, p. 110
      (b) Flowers smaller, borne in flat-topped clusters; fruits small, applelike. CRAB APPLE, p. 110.
  B. Trees with inconspicuous greenish flowers, often in drooping tassels.
    1. Fruits small cone-like structures; leaves oval or egg-shaped with toothed margins and prominent veins.
      (a) Cones woody, remaining on the tree for long periods...ALDERS, p. 111.
      (b) Cones composed of thinnish overlapping scales, falling to pieces on the tree when the seeds are ripe........................BIRCHES, p. 112.
    2. Fruits tiny pods which split to free cottony seeds, borne close together on slender stems.
      (a) Leaves commonly broad, at least at the base (except narrowleaf cottonwood)..........................COTTONWOODS and POPLARS, p. 113.
      (b) Leaves commonly long and narrow.................WILLOWS, p. 116.
    3. Fruits neither cones nor pods.
      (a) Fruits winged seeds borne in drooping clusters; found in the Southwest.................................SINGLELEAF ASH, p. 109.
      (b) Fruits small hard orange berries; leaves egg-shaped with unequal base, dark green and roughish; found in the Southwest....HACKBERRY, p. 117.
      (c) Fruits acorns; leaves oval or oblong, variously toothed or with smooth margins..OAKS, p. 118

California sycamore (*Platanus racemosa* Nutt.).—Only one species of sycamore is found in the Coast region and it occurs only in one of the California parks. One of the most distinctive characteristics of California sycamore is its thin, smooth, whitish bark. This is shed annually in thin, veneerlike sheets exposing the pale, olive-green inner bark which later becomes chalky white. The tree may also be distinguished by its fruits which are round greenish balls hanging from threadlike stems. Hence, it is sometimes called "button-ball" tree. The leaves are similar to those of the bigleaf maple, but are thicker and finely hairy, especially on the veins. California sycamore, being dependent upon constant soil moisture, is usually found along streams or in deep moist canyons. The wide-spreading branches close to the ground furnish a splendid shade.

Description.—An open, irregularly branched tree, usually with a rather short trunk; bark dull brown and rough only at the base; thin, smooth, and ashy white above with greenish-gray areas; leaves large, 5 to 11 inches across, 3 to 5-parted, alternate on the branchlets, flowers and fruits very small, crowded together in ball-like heads about 1 inch in diameter, the heads on long stems usually 5 to 10 inches long.

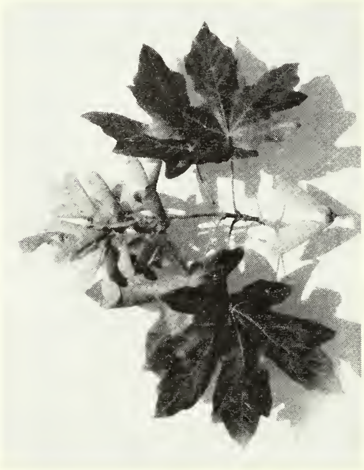

FIGURE 62.—Bigleaf maple.

Occurrence.—Sequoia, common along stream bottoms, 1,300 to 4,200 feet: Ash Mountain; North Fork, Kaweah River; Paradise Creek.

Bigleaf Maple (*Acer macrophyllum* Pursh.) (fig. 62).—This maple is well named, for it has the largest leaf of any maple in the western United States. It generally occurs sparsely scattered along the border of streams or in very moist places. Only in open sites does the tree develop its fine rounded crown and dense foliage. In the autumn the leaves take on a golden yellow color instead of the innumerable shades of red and yellow common to some maples. The flowers, coming out with the leaves, are attractive to bees. Squirrels and birds are very fond of the seeds which the tree may bear in large quantities. This tree will produce maple sugar in nearly as good quality and as good quantity as the eastern sugar maple.[9]

Description.—Trees grow in the open with broad, round crowns and short trunks, those produced in dense forests with short, narrow crowns and with tall trunks clear of branches for a considerable distance; bark grayish to reddish brown, rough with hard scaly ridges; leaves round in outline, 5-parted, smooth, thickish, 6 to 14 inches long, with stems about as long; fruit a pair of winged seeds, with the wings nearly parallel, and the two seed portions covered with bristly hairs.

Occurrence.—Olympic, common at lower elevations: Hoh River; Olympus guard station, 1,000 feet. Mount Rainier, occasional, 2,000 to 3,500 feet: Sunset Park; Longmire Road. Yosemite, occasional, up to 5,600 feet: Along Merced River; near Yosemite

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[9] Van Dersal, W. R., Native woody plants of the United States, p. 40, 1938.

Falls; Ahwahnee Hotel; near Nevada Falls; along Tenaya Creek. Sequoia, occasional, up to 3,800 feet: Clough Cave; west of Panorama Peak.

Boxelder (*Acer negundo* L. var. *interior* (Britt.) Sarg.) (fig. 63). Boxelder is common along streams or in moist canyons in the Southwest. The leaves, in contrast to those of other maples, are compound. They are made up of three to five smaller leaflets joined at the same point on the leaf stem. The fruits are winged seeds borne in pairs.

Description.—Tree 20 to 50 feet high, with a short trunk 10 to 30 inches in diameter and a broad dense crown; bark rough, grayish brown; leaves in opposite pairs on the branchlets, divided into three or sometimes five smaller leaflets with more or less jagged edges, seeds in winged pairs, the wings spreading obliquely.

Occurrence.—Mesa Verde, present: West of Prater Canyon ranch house. Zion, common, 4,500 feet: Along the Virgin River; Zion Canyon near Zion Lodge. Grand Canyon, occasional on the North Rim and in the canyon: Cliff Spring; Bright Angel Canyon; Roaring Springs Canyon.

California buckeye (*Aesculus californica* Nutt.). This is a tree of the lower foothill regions in California. It is very similar to the cultivated horse chestnut except that the latter has rose-colored flowers. The common name, buckeye, is said to be derived from the fact that the shiny, brown seed showing from the yellowish, leathery husk resembles the eye of a deer or buck. The low, round-topped trees are often conspicuous in ravines and hollows or on gentle slopes because of the light green foliage. In spring the long dense clusters of white flowers standing erect above the crown make this one of the most showy of trees, and during the winter, the leafless branches stand out like skeletons on the landscape. Though the seeds resemble chestnuts, they are not edible. However, the Indians prepared them for food by grinding the pulp and then leaching out the astringent properties. It has been reported that cattle have been killed by eating them when other food was scarce. It is also said that bees are poisoned by the nectar from the flowers.[10]

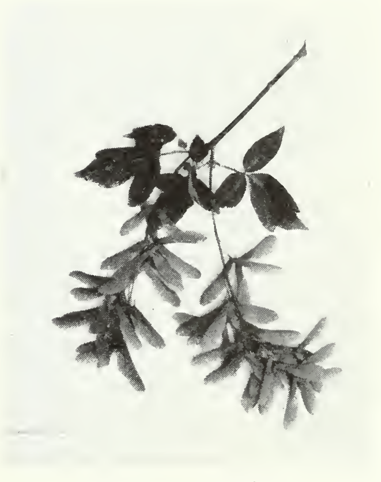

FIGURE 63.—Boxelder.

Description.—Low, round-topped tree, 10 to 20 feet high (or occasionally 25 to 30 feet), with dense foliage and smooth, light gray bark; leaves composed of five oblong leaflets 3 to 7 inches long, joined in a group at the tip of a slender stem about as long as the leaf; flowers white, ill-smelling; fruit a leathery pod containing a brown chestnutlike seed 1 to 2 inches in diameter.

Occurrence.—Yosemite, occasional, 2,500 feet: Merced River at the park boundary; Hetch Hetchy. Sequoia, common, 2,000 to 4,500 feet: Generals Highway; Hospital Rock.

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[10] Van Dersal, W. R., Native woody plants of the United States, p. 43, 1938.

Honey mesquite (*Prosopis juliflora Benth. var. glandulosa* (Torr.) Ckll.).—This tree or shrub is a native of the arid Southwest, where it is able to thrive under the severe desert conditions because of the remarkable development of a huge taproot system. This may be out of all proportion to the small, often insignificant, stems above the ground. The root descends sometimes to a depth of 50 or 60 feet. Its wood is heavier and harder than that of the stem and furnishes excellent fuel. Indians gather the beans and grind them into a meal for bread, using pods and all. The leaves and pods are also utilized by grazing animals. Honey bees obtain excellent nectar from the flowers and the honey produced is clear and fine-flavored, hence the common name "honey mesquite."

Description.—A shrub or small tree with the trunk branching close to the ground and a low, rounded, wide-spreading crown: leaves compound, composed of very small leaves (leaflets) in several pairs on a slender stem, these again paired on a larger stem; a curved spine (or sometimes two) at the base of the main leaf-stem; flowers yellow, crowded in spikes 2 to 3 inches long; pods several in a cluster, 4 to 8 inches long, 6- to 20-seeded, constricted between each seed.

Occurrence.—Zion, present: Near Coalpits Wash. Grand Canyon, common in the canyon: Colorado River.

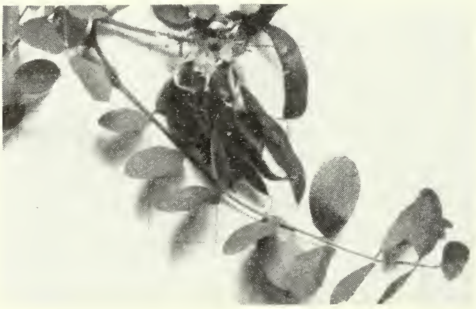

FIGURE 64.—Southwestern locust.

Southwestern locust (*Robinia neomexicana* Gray.) (fig. 64).—The Southwestern locust is similar in foliage to the eastern black locust but differs in having rose-colored flowers and hairy leaves and pods. It favors cool mountain canyons or streams but may occur also on dry hills. This species is not known to be poisonous. The flowers were eaten fresh by the Indians of certain regions of the Southwest and both the flowers and leaves are grazed by the muledeer on the Kaibab range in the Grand Canyon area.

Description.—Shrub or small tree with stout, sharp, straight or backwardly-curved spines at the leaf bases; young stems hairy; leaves divided into several pairs of opposite leaflets; flowers rose-pink, similar to sweetpea flowers, borne in showy oblong clusters 2 to 4 inches long; pods flat, 2 to 4 inches long, about ¼ inch wide, covered with stiff brownish hairs.

Occurrence.—Zion, common in the canyons, about 4,000 feet: Talus slope along Zion Canyon Road north of campground. Grand Canyon, North Rim, common on the Kaibab Plateau. South Rim, rare: Dripping Springs.

Black locust (*Robinia pseudoacacia* L.).—Black locust is a species of the eastern United States which has been widely cultivated in the West. It was brought into Zion Canyon by early settlers. This species differs from the New Mexican locust in having white flowers and smooth leaves and pods. The foliage is said to be poisonous.

Description.—Small tree or shrub with spreading, usually thorny branches; leaves divided into several pairs of smaller leaflets; flowers white in showy oblong clusters, the clusters 4 to 6 inches long; pods flat, 1 to 4 inches long, about ½ inch wide, smooth.

Occurrence.—Zion, occasional in Zion Canyon.

Velvet ash (*Fraxinus velutina* Torr.), and **Desert ash** (*F. velutina* var. *coriacea* (Wats.) Jepson) (fig. 65).—This is one of the common trees along streams in the desert regions of the Southwest. The ashes are easily recognized by their fruits, which have a single narrow or oblong wing. They are borne on slender stems hanging in dense clusters from the branches. Rodents are said to utilize them to a certain extent for food. Desert ash differs from velvet ash in having the leaf divisions (leaflets) shorter and more leathery.

Description.—Slender, short-trunked tree, 15 to 30 feet high, with grayish to faintly reddish bark; trunk broadly ridged; leaves opposite each other on the stem, 4 to 6 inches long, each divided into usually 5 smaller oblong leaves (leaflets); leaflets 3 to 5 inches long (2 to 3 inches long in var. *coriacea*), usually pointed at the tip, indistinctly fewtoothed; flowers tiny and inconspicuous, hanging in dense clusters from the branches before the leaves appear in the spring; fruits about ½ to 1 inch long, ½ inch wide, hanging in dense but loose clusters 3 to 5 inches long.

Occurrence.—Zion, present, 4,000 feet: Zion Canyon; near the south entrance to park.

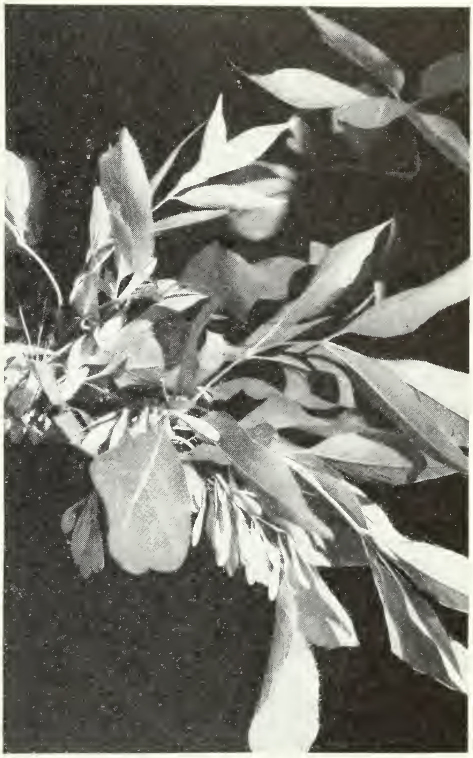

Figure 65.—Desert ash.

Singleleaf ash (*Fraxinus anomala* Wats.) (fig. 66).—This is a common shrub or tree in the Southwest found growing along intermittent streams and in canyons, or occasionally on dry, rocky hillsides. It has the distinction of being the only single leaf ash, the others always having more than one leaf (leaflet) to each leaf stem.

Description.—A small tree 20 to 50 feet high or a low spreading shrub; bark on the trunk and larger stems rough and cracked; leaves roundish in outline, somewhat tapering towards the base, ¾ to 1½ inches long, single or sometimes divided into 3 (rarely 5) parts, occurring in opposite pairs on the stems; fruits hanging in bunches from the branchlets, each composed of an oblong wing with a small seed at its base.

Occurrence.—Zion, occasional, 5,000 to 6,000 feet: Talus slopes in canyons; along Zion Canyon Road near the Organ. Grand Canyon, occasional, 4,000 to 5,000 feet: Bright Angel Canyon; Havasu Canyon; Grandview Trail; Horn Creek.

California laurel (*Umbellularia californica* Nutt.).—The California laurel, also called Oregon myrtle and bay tree, is found only in California and southwestern Oregon and occurs in only two of the national parks. It has evergreen foliage which is easily distinguished from that of any other tree within its range by the very strong, sharply aromatic odor.

Description.—Usually a tree 20 to 30 feet high, with a dense round crown of slender erect branches, or sometimes a shrub 4 to 10 feet high; young stems smooth and grayish brown; leaves oblong, tapering at both ends, the margins smooth, 2½ to 4½ inches long, shiny dark green above; flowers greenish yellow, in small dense clusters at the ends of the branchlets, the clusters closely surrounded by the leaves; fruits about the size of a large olive, one-seeded, greenish, turning brown-purple or black.

Occurrence.—Yosemite, common, 3,500 to 5,000 feet; Yosemite Valley; Yosemite Falls Trail; Tenaya Lake Trail, Sequoia, common at the lower elevations: Generals Highway between Ash Mountain and Giant Forest.

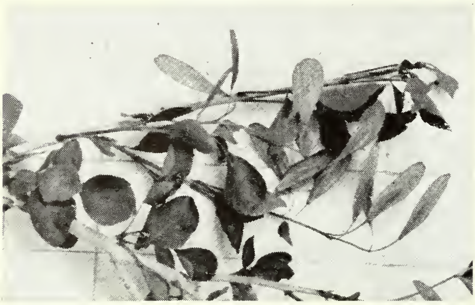

FIGURE 66.—Singleleaf ash.

Oregon crab apple (*Malus rivularis* Roem.).—Oregon crab apple, a tree of the northern Pacific coast, is generally found at lower elevations than are included in the park areas, but it is sometimes found in Olympic National Park and on the west side of Mount Rainier. The trees seen in the Olympics were much bent and gnarled as though having a hard struggle to continue existence in the dense forest of Douglas fir and hemlock.

Description.—Small tree 10 to 30 feet high; leaves egg-shaped, pointed at the tips, the margins toothed, sometimes with 3 broad pointed divisions; flowers white, about ¾ to ½ inch across, borne in flat-topped clusters; fruits applelike, about ½ inch in diameter.

Occurrence.—Olympic, rare: Elwha River near Elkhorn Guard Station, 1,374 feet. Mount Rainier, rare, up to 2,500 feet.

Pacific dogwood (*Cornus nuttallii* Aud.).—This is the most conspicuous of all our western dogwoods, being the only one attaining tree size. It is a rare sight in the spring to come upon a tree of western dogwood covered with its immense white flowers, sometimes 6 inches across. The so-called "flowers" are not flowers at all, but a headlike cluster of many small flowers surrounded by usually 6 large, petallike scales called bracts. The leaves turn a dull red in the autumn and the showy bracts wither and fall, leaving dense heads of bright red fruits which are very palatable to birds. The species occurs on the Pacific slope from British Columbia to southern California, growing usually under Douglas fir, western hemlock, or redwood, and mixed with maple, willow, or alder.

Description.—Tree 10 to 30 feet high with a smooth trunk 6 to 12 inches in diameter; bark ashy brown or reddish, smooth (or scaly on old trunks); leaves broadly oblong or oval, rounded or shortly pointed at the tips, 3 to 5 inches long, opposite each other on the stem and tending to be clustered towards the ends of the branches; flowers greenish or yellowish, crowded in heads ½ to 1 inch through, surrounded below by 4 to 8 (usually 6) broad petal-like bracts; bracts white or tinged with red, 1½ to 3 inches long; fruits red, ½ inch long, borne in dense headlike clusters.

Occurrence.—Olympic, occasional: Lake Crescent; Elwha River; north of Wildrose Creek, 2,500 feet. Mount Rainier, rare in Douglas fir and western hemlock forests: Ohanapecosh River near Ohanapecosh Hot Springs. Lassen, present. Yosemite, occasional. Sequoia, occasional: Along the Generals Highway above Ash Mountain; northeast of Marble Falls.

Red alder (*Alnus rubra* Bong.), (*Alnus oregona* Nutt.), **White alder** (*Alnus rhombifolia* Nutt.) (fig. 67).—These are common woodland trees found along streams in lower canyon bottoms or in other moist locations on the Pacific slope. The presence of alder is said to be a good sign of water because it grows only in permanently moist situations. The shallow spreading roots of these trees are of particular importance along streams as protection against erosion. Alders are found from Alaska to Southern California, in pure stands or mixed with conifers or other broadleaf trees. In the parks the red alder occupies the northern part of the range while white alder occurs to the south. The two are very similar in appearance but may be distinguished by the bark and leaves. The bark of white alder is brown and scaly for some distance up the stem, while the red alder has whitish or gray-brown outer bark, usually smooth and unbroken, and reddish inner bark and wood. The sap of the latter turns a dull red when exposed to the air. The leaves of red alder are more coarsely toothed than those of white alder and the margins have a very narrow in-rolled edge. On the roots of alders are produced small nodules in which live

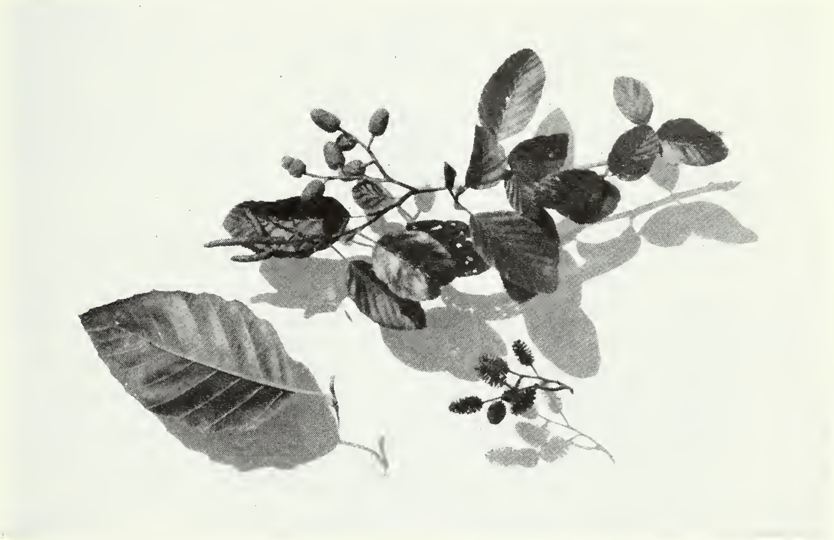

Figure 67.—White alder.

bacteria having the power to take nitrogen from the air and combine it into compounds which may be utilized by plants. When the roots bearing these nodules die, the nitrogen is made available to the plants.

Description.—Trees 50 to 90 feet high with open domelike crown and decidedly drooping lower and middle branches, or, under forest conditions the trunk straight and clear of branches ½ to ⅔ of its length; bark rather thin, white-mottled and smooth on young trees but roughened with irregular black patches on older individuals of red alder and brown and scaly on white alder; leaves oval, strongly veined, 2½ to 5 inches long, light or dark green above, paler below, those of white alder with finely toothed margins, those of red alder with scalloped margins and in-rolled edges; male flowers in tassellike clusters, 5 to 6 inches long and about ¼ inch thick; female flowers in tiny ovoid cones borne in clusters; the cones dark brown when mature, remaining persistent during the winter; seeds tiny, with narrow winglike margins.

Occurrence.—Red Alder, Olympic, common: Lake Crescent; Camp Wilder, Elwha River; Hoh River; Enchanted Valley. Mount Rainier, common, 1,800 to 3,500 feet: Longmire checking station; White River Camp. White Alder, Yosemite, occasional, 2,500 to 5,400 feet: Along all the larger streams; Yosemite Valley; northeast of Alder Creek ranger station. Sequoia, common, 2,000 to 4,500 feet: Marble Fork of Kaweah River; Paradise Creek.

Red birch (*Betula fontinalis* Sarg.).—Red birch or mountain birch, sometimes called water birch, black birch, or sweet birch, is a graceful, dainty-looking tree or shrub. It is commonly found in damp areas around springs or along streams. Like the alder, the seeds are produced in tiny cones, but they differ in that they are borne erect and fall to pieces when the seeds are ripe. There is only one cone to a twig instead of several as in the alder.

Description.—A slender, graceful tree or tall shrub with open crown; branches slender, the delicate pendent twigs covered with shiny resinous dots; bark smooth, often with a reddish metallic sheen, does not break to form bands or "curls" as in other birches; leaves thin, oval or roundish, 1 to 2 inches long, pointed at the tip and toothed along the edges, turning a beautiful clear yellow in the fall; fruits small slender cones about 1 to 1½ inches long, borne more or less erect on the branchlets, the scales falling away when the seeds are ripe; seeds tiny nutlets with broad thin wings.

Occurrence.—Glacier, occasional: Along creek near St. Mary. Yellowstone, present, 6,500 to 7,500 feet: Along Boiling River; near Firehole bridge. Rocky Mountain, occasional. Zion, occasional, 4,000 to 6,500 feet: Trail from Zion Lodge to Birch Creek; Weeping Rock; Emerald Pools; Grotto; West Rim ranger cabin. Grand Canyon, North Rim: Bright Angel Spring; around the springs in South Big Spring Canyon; near Kanabownits Spring.

Paper birch (*Betula papyrifera* Marsh.).—Paper birch is found from the Atlantic to the Pacific and from the northern United States to the Arctic, but does not occur in the western parks with the exception of Glacier and Mount McKinley. It grows in deep woods, along river banks, or on mountain slopes, most often occurring in pure or nearly pure stands, especially in burns. It is one of the most easily identified and best known trees throughout its range, the most characteristic feature being its glistening, chalky-white bark which separates into thin sheets. It is unfortunate that there is such a fascination in peeling off the thin layers of bark because the trees are easily killed by this destructive practice. It is from the bark of this tree that the Indians built their birch-bark canoes.

Description.—Tree 40 to 60 feet tall, older trees with a narrow open head of pendulous branches; bark chalky white outside, bright orange colored within, marked with numerous horizontal lines and peeling readily into thin papery scales; leaves oval with a round or wedge-shaped base and pointed tip, bright green, turning clear yellow in the fall; cones 1 to 2 inches long, cylindrical, on slender stalks, composed of thin overlapping scales enclosing tiny winged seeds; wood light, close-grained, hard and tough but not very durable; heartwood reddish brown; sapwood nearly white.

Occurrence.—Glacier, occasional on the west side, 3,800 to 5,500 feet: Along Avalanche Creek; Lake McDonald; Flathead River at Belton. Several beautiful trees may be seen on the lawn overlooking the lake in front of Lake McDonald Hotel.

Western white birch (*Betula papyrifera* var. *occidentalis* (Hook.) Sarg.).—This is a rare tree in park areas, being found only occasionally in Glacier National Park. It is similar to canoe birch except that the trees are usually smaller and the bark is a smooth, shiny, reddish brown in contrast to the chalky white of canoe birch.

Description.—Tree 15 to 40 feet high or occasionally higher; bark red-brown, separating into thin layers; leaves thin, egg-shaped with a pointed tip and toothed margins, about 2 to 4 inches long, somewhat hairy beneath; cones 1 to 2 inches long.

Occurrence.—Glacier, occasional on the east side, 3,500 feet.

Field Guide to the Species of Poplars

I. Leaf-stems flattened just below the leaf-blade.
  A. Leaf-stems strongly flattened; leaves roundish with smooth margins; trees found at higher elevations in all the western national parks (except the northwest), though often sparingly . . . . 1. *Aspen.*
  B. Leaf-stems only slightly flattened; leaves more or less triangular, the margin toothed; commonly found at lower elevations in the Southwest parks
  2. & 3. *Fremont* and *Wislizenus Cottonwoods.*

II. Leaf-stems not flattened; leaves longer than broad.
  A. Leaves narrow, green on both sides; found in the Rocky Mountain parks
  4. *Narrowleaf cottonwood.*
  B. Leaves dark green above, paler or often whitish or rusty below.
    1. Pods smooth; tree of the Rocky Mountain region . . 5. *Balsam poplar.*
    2 Pods finely hairy; tree of the Pacific slope region . . 6. *Black cottonwood.*

1. **Aspen, quaking aspen** (*Populus tremuloides* Michx.) (fig. 68).—Aspen is one of our best known trees partly because it is so widely distributed and partly because it is so easily recognized. The tree has an unmistakable smooth whitish trunk and an open crown covered with small yellow-green leaves which dance and tremble with the slightest breeze. The gorgeous golden color which the foliage assumes during the autumn is one of the outstanding charms of the aspen woodlands. The seeds germinate quickly in burned-over areas and the seedlings grow rapidly, forming thickets in exposed situations. The young trees are soon crowded out, however, by more aggressive shade-enduring associates. At very high elevations, as near timber line, the trees are often scrubby in form. Aspen bark is a

favorite food of the beaver, and deer browse on the leaves. A decoction of the bark is said to have been used by the Indians for intermittent fevers.

Description.—A slender, graceful tree usually 10 to 60 feet high with an open crown, or, in high exposed places, dwarfed and shrublike with bent or almost prostrate stems; bark smooth, whitish, with black lines near the bases of the older trunks where the outer bark has broken; leaves smooth, somewhat shiny, deep yellow-green above, paler beneath, 1 to 3 inches long, roundish but with pointed tips and very finely toothed margins; leaf stems yellow, flattened near the leaf-blade; flowers and fruits in long hanging clusters; seeds surrounded by cottony hairs.

Occurrence.—Crater Lake, occasional at the lowest elevations: Southeast corner of the park; Pinnacles. Lassen, rare. Yosemite, occasional, 6,000 to 9,500 feet: Aspen Valley; Little Yosemite; near Bridal Veil Creek. Sequoia, common, 6,500 to 10,000 feet: Trail to Alta Peak; patch on Kern-Kaweah River at 10,000 feet. Glacier, common, 5,700 to 6,300 feet: Belton; along auto roads on east side of park; Sherburne Lake checking station. Yellowstone, abundant: East entrance; below north junction of Mount Washburn Road; along Gneiss Creek. Grand Teton, abundant, 6,500 to 8,500 feet: Granite Canyon. Rocky Mountain, abundant, 8,500 to 10,500 feet. Mesa Verde, rare: Northern part of the park; head of Prater Canyon. Bryce, rare, 7,800 to 8,800 feet: In draw below Union Pacific Spring; Swamp Canyon; Whiteman Cave. Zion, occasional, 6,000 to 7,000 feet: South end of Horse Pasture Plateau; south end of Potato Hollow; West Rim Trail at ranger cabin; south side of Zion Canyon near south entrance. Grand Canyon, 7,000 to 9,000 feet: North Rim, abundant. South Rim, rare: Grandview Point.

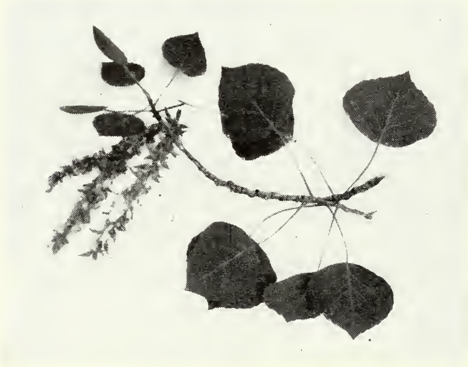

FIGURE 68.—Aspen.

2. **Fremont cottonwood** (*Populus fremontii* Wats.) (fig. 69), 3. **Wislizenus cottonwood** (*Populus wislizenii* Sarg.).—The cottonwood is very important in the Southwest because of the protection it gives to the unstable banks of meandering desert streams. It is often the only tree along these water courses and often assumes a bent or reclining position. Fremont and Wislizenus cottonwood are very similar in appearance, the chief difference being in the fruits which are long-stemmed in the latter and short-stemmed in the former. The difference in their distribution is the easiest way to tell them apart. Fremont cottonwood occupies the more western part of the range while Wislizenus cottonwood is found at Bryce Canyon and Mesa Verde National Parks. Because these trees are well adapted to the warm climate of the Southwest, they are being planted extensively in their natural areas for erosion control. These cottonwoods are among the best of shade trees.

Description.—Round-topped, open-branched trees with the trunks clear of branches for about half their length, or the trunk sometimes leaning or nearly prostrate; bark furrowed, pale grayish-brown or dark-brown; leaves bright shiny green, broadly triangular with a pointed tip, 2 to 2½ inches long, 2½ to 3 inches wide, with round-toothed margins; leaf stems 1½ to 3 inches long, flattened; fruits tiny pods borne in long, wormlike clusters, each pod breaking into 3 or 4 sections to free small cottony masses containing the seeds.

Occurrence.—*Populus fremontii.* Sequoia, at the lowest elevations: North Fork Kaweah River, 1,300 feet. Zion, rare, 3,500 to 4,500 feet: Along streams. Grand Canyon, present in the canyon, 3,000 feet: Bright Angel Creek; Phantom Ranch; Indian Gardens. *Populus wislizenii.* Mesa Verde, present: Navajo Canyon. Bryce, present in the lower valleys.

4. **Narrowleaf cottonwood** (*Populus angustifolia* James).—This is a common tree on the banks of mountain streams at middle elevations in the Rocky Mountains and in the Southwest. Its long, narrow leaves, green on both sides, make it easily distinguishable from the other cottonwoods of the regions in which it grows.

Description.—Slender tree, 50 to 60 feet high with trunks up to 3 feet in diameter; crown narrow with slender branches tending upwards; bark rough and furrowed, light yellow-green on young trees; leaves bright yellow-green above, paler below, 2 to 4 inches long (or sometimes 6 or 7 inches); ½ to 1 inch wide, rounded at the base and tapering gradually to the pointed tips; leaf-stems not flattened; flowers and fruits in long, wormlike clusters; the fruits tiny pods splitting into two sections; small seeds surrounded by white cottony hairs.

Occurrence.—Yellowstone, occasional: Tower Falls; Mammoth; along the Gardiner River. Grand Teton, occasional, 6,500 feet: Eastern park boundary at S. T. S. Ranch. Rocky Mountain, common along streams. Bryce Canyon, present along streams. Zion Canyon, present: Northeast boundary; Zion Canyon, near Zion Lodge; top of Cable Mountain.

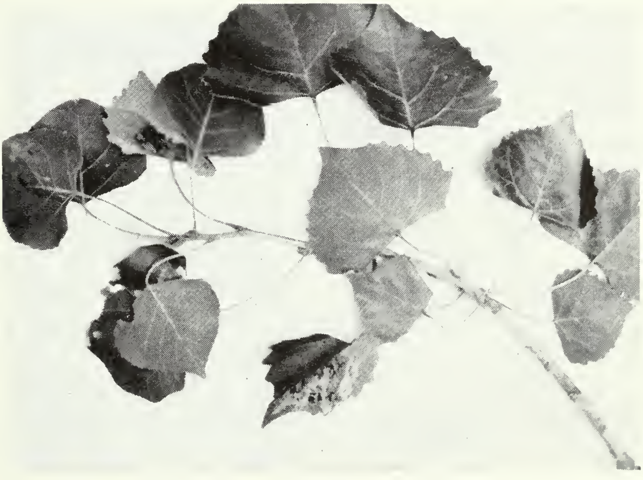

Figure 69.—Fremont cottonwood.

Balsam poplar (*Populus balsamifera* L.). Balsam poplar is widely distributed in the United States from the Rocky Mountains east to the Atlantic Coast. The species is known also as *Populus tacamahaca* Mill. and there is still some confusion among botanists as to whether this is truly the balsam poplar described by Linnaeus or whether that name should be given to the eastern species known also as *Populus deltoides*.[11] The tree is very similar to the black cottonwood of the Pacific Coast region. Both have dark green lustrous leaves with the undersides pale or rust-colored and very veiny. The tiny pods of black cottonwood are finely white-hairy, while those of balsam poplar are smooth, though usually warty. In the absence of fruits the two species may be distinguished by their respective ranges, black cottonwood occurring on the Pacific Slope while balsam poplar is found in the Rocky Mountains and East.

Description.—Same as for black cottonwood except as noted above. Some trees having heart-shaped leaves were found along the edge of the lake in front of Lake McDonald Hotel at Glacier National Park, but stump sprouts from the same trees were of the usual more or less triangular shape. Also, the leaves on stump sprouts and in shrubby forms are sometimes as narrow as those of narrowleaf cottonwood.

Occurrence.—Glacier, occasional, 3,100 to 5,000 feet: Flathead River at Belton; Lake McDonald; Avalanche campground; Sprague Creek campground. This tree is described as *Populus hastata* by Standley in the *Flora of Glacier National Park.* Yellowstone occasional: Tower Falls; east entrance; lower Lamar River; lower Yellowstone River. Grand Teton, rare: Mouth of Death Canyon, 6,800 feet; Jenny Lake. Rocky Mountain, rare: Fern Lake Trail; Wild Basin.

6. **Black Cottonwood** (*Populus trichocarpa* T. & G.).—Black cottonwood may be distinguished by its deeply furrowed bark, the ridges sometimes nearly 2 inches across, and by the thickish, leathery, narrowly egg-shaped leaves which are dark green above and whitish beneath, often with rusty spots. The straight trunks are often clear of branches 50 to 80 feet or more. This tree grows best in the rich soil along rivers or in canyon bottoms where abundant moisture is available.

Description.—Trees 30 to 125 feet high with trunks 3 to 4 feet in diameter; crown short and broad, the trunk commonly clear of branches for two-thirds or more of its length; bark pale gray with a yellowish cast, deeply furrowed; mature leaves 2½ to 3½ inches long, thick and leathery, narrowly triangular, tapering abruptly to the base or sometimes somewhat rounded, pointed at the tips, the margin finely toothed, shiny green above, silvery white beneath, often with rusty patches; fruits borne in long, hanging clusters 4 to 6 inches long; fruits small roundish pods splitting into 2, 3, or 4 sections to free the cottony masses containing the seeds.

Occurrence.—Olympic: Elwha River, near Leitha Creek. Mount Rainier, occasional along the rivers, 2,000 to 4,000 feet: West Fork White River. Crater Lake, rare: Southeast corner of the park. Yosemite, common along the rivers, 3,000 to 7,000 feet: Hetch Hetchy Valley; Yosemite Valley; Wawona; above mouth of Return Creek. Sequoia, occasional, 6,500 feet: Kern Canyon. Glacier. Near the east entrance to the park, according to Standley, but we were unable to authenticate this locality (*see* balsam poplar).

Willows (*Salix* L.).—The willows as a group are easily distinguished from other trees by the usually long narrow leaves and the cottony seeds similar to those of the cottonwoods. Among themselves, however, the species are very variable and difficult to identify. Willows are found most commonly along streams or in other moist sites where their roots have a constant supply of water. Here they are of great importance in holding the soft or sandy stream banks in place. The tiny flowers are borne in soft slender clusters along the stems. Probably everyone has gone out at some time or another to gather "pussy willows." The male and female flowers are borne on separate trees and in some species appear before the leaves. Willow stumps sprout very easily. The sprouts are generally stronger and more withy than the twigs from the crowns of the trees and are used extensively in Europe for making crates and small baskets. The wood is soft, light, often brittle, and not at all durable. The leaves and roots of some of the willows are reputed to have been used by the Indians in making a decoction for skin affections. Some of the more common and easily distinguished tree species will be briefly considered here.

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[11] Sudworth, G. B., Poplars, principal tree willows and walnuts of the Rocky Mountain region, p. 11: U. S. Dept. Agr. Technical Bulletin No. 420, 1927.

Narrowleaf black willow (*Salix gooddingii* Ball). (*Salix nigra var. vallicola* Dudl.).—Usually a tree 20 to 45 feet high, with a short trunk 10 to 30 inches in diameter and a broad rounded crown; bark dark gray or blackish, cut into deep furrows; foliage yellowish green; leaves 1½ to 6 inches long, ¼ to ½ inch wide, commonly slightly curved above the middle, the margins shallowly cut into short glandular teeth; trees occurring on borders of streams in the Southwest and extending as far north as middle California.

Occurrence.—Yosemite, along the rivers at low altitudes. Zion, common along the Virgin River. Grand Canyon, common in the canyon.

Red willow, black willow (*Salix laevigata* Bebb).—Straight-trunked tree, 20 to 50 feet high, with trunk up to 2 feet in diameter; bark blackish-brown, furrowed on the main trunk, the twigs dark orange to red-brown; leaves narrowly oblong, tapering to a point, 3 to 7 inches long, ¾ to 1½ inches wide, dark shiny green above, pale or silvery beneath, the margins finely toothed, or nearly smooth; flower clusters 2 to 4 inches long, appearing in the spring with the leaves; trees usually found along permanent streams in the valleys and foothills.

Occurrence.—Yosemite Bear Creek, Big Oak Flat road, 7,200 feet. Zion, along the Virgin River.

Western black willow (*Salix lasiandra* Benth.).—Tree 20 to 60 feet high with narrow open crown (or sometimes a shrub); bark dark-brown, roughly fissured; leaves 2 to 7 inches long, ½ to ¾ inch wide, tapering to a long slender point, shiny deep yellow-green above, paler below, with finely-toothed margins. It is said that in the old days in California, the Spanish saddle-trees were made from selected pieces of western black willow and red willow, *Salix laevigata.*

Occurrence.—Olympic, along the Elwha River; Mount Rainier; Yosemite, along Merced River; Sequoia, along the rivers; Yellowstone.

Variety *lancifolia* (Anderss.) Bebb. *Occurrence.*—Rocky Mountain; Mesa Verde.

White willow (*Salix lasiolepis* Benth.).—Shrub or tree 9 to 40 feet high with rather narrow, irregular, open crown; leaves oblong or linear, pointed, obscurely toothed, green above, pale or white below, 1½ to 5 inches long, ⅓ to 1¼ inches wide.

Occurrence.—Yosemite, near western park boundary; Zion, along the Virgin River.

Mountain willow (*Salix scouleriana* Barr.).—Tree 20 to 30 feet high, or a shrub at higher elevations; leaves oblong or egg-shaped, tapering to the base and either rounded or shortly pointed at the tip, 1 to 4 inches long and ½ to 1½ inches wide, shiny dark green above, paler and often densely short-silky below; flower clusters large, oval, ½ to 1 inch long, about ½ inch wide, appearing before the leaves; the most common willow in the mountains of the Northwest.

Occurrence.—Olympic; Mount Rainier; Crater Lake; Yosemite; Sequoia; Glacier; Yellowstone; Grand Teton; Rocky Mountain; Zion.

Hackberry (*Celtis douglasii* Planch).—This tree may be distinguished by the thick, rough, dark-green leaves unequal at the base and with 3 prominent side veins. The foliage usually spreads out more or less horizontally from the stems to form more or less flat sprays. Hackberry is found in only two of the parks and is never abundant in either. It occurs in dry or gravelly soils in canyons or in desert gulches bordering rocky streams. The small cherrylike fruit is said to have been eaten by the Indians.

Description.—Usually a small tree, 15 to 30 feet high, with round crown and short trunk; bark bluish ashy-gray, rough with prominent projecting ridges; leaves oval, somewhat heart-shaped and unequal at the base, thick and leathery, with three main veins, dark green above, light yellowish-green below, and usually very rough to the touch; fruits small, cherrylike, orange-brown or yellow, with thin, dry, sweetish flesh covering a hard seed.

Occurrence.—Zion, occasional in shrubby form, 5,000 feet: Zion Canyon below the Organ. Grand Canyon, rare in the canyon: Cataract Canyon; Havasu Canyon; Dripping Spring; Bright Angel Trail.

Field Guide to the Species of Oaks

I. Found only in the parks of the Southwest; leaf-margins cut into several broad sections . . . . 1. *Rocky Mountain White Oak.*
II. Found only in California parks.
  A. Leaves, ¾ to 3 inches long, not divided into distinct divisions, but sometimes with the margins toothed.
    1. Trees losing their leaves each fall; leaf-margins smooth, or sometimes with broad shallow divisions; found only at Sequoia National Park 2. *California blue oak.*
    2. Trees, evergreen; leaves with margins smooth or spine-toothed; found at Yosemite and Sequoia National Parks.
      (a) Leaves green and smooth on both sides . . . . 3. *Highland live oak.*
      (b) Leaves green and smooth above, with a yellowish fuzz below 4. *Canyon live oak.*
  B. Leaves, 1½ to 8 inches long, divided into broad, bristle-tipped divisions.
    1. Leaves shallowly divided, 1½ to 4 inches long; trees semi-evergreen; found at Yosemite and Sequoia National Parks (very rare) . . . . . 5. *Evergreen black oak*
    2. Leaves deeply divided, 4 to 8 inches long; trees losing their leaves each fall; found only in California parks . . . . 6. *California black oak*

1. **Rocky Mountain white oak** (*Quercus utahensis* (A. DC.) Rydb.), (*Quercus leptophylla* Rydb.).—This oak is very similar to the shrub, Gambel oak, and for convenience may be considered as a tree form of the Gambel oak. The Rocky Mountain white oak and the Gambel oak both occur in the same region and are so similar that even the botanist has difficulty in distinguishing between them. They are differentiated primarily on leaf differences which are very variable.

Description.—Small tree up to 30 or 45 feet high; leaves 2 to 4 inches long, oblong, rounded at the tip and deeply divided into several broad rounded sections, smooth, dark-green and shiny on the upper surface, paler and softly hairy below; acorn oval, ¾ to 1 inch long, light brown, set in a rather thick or corky cup.

Occurrence.—Mesa Verde, abundant, 6,400 to 8,000 feet: The common tree oak on the plateau; around the north base of Navajo Hill. Bryce, abundant, 6,800 to 8,500 feet. Zion, present, 5,000 to 7,500 feet: The most common oak on the plateaus; west rim trail between the ranger cabin and Sleepy Hollow. Grand Canyon, 5,500 to 8,700 feet: North Rim, abundant in the ponderosa pine belt: Powell Plateau. South Rim, common. Canyon, occasional; Bright Angel Trail.

2. **California blue oak** (*Quercus douglasii* H. & A.).—Blue oak is so-called because of the dull blue-green color of the foliage, but it is locally known also as white oak because of its light ashy-gray bark. The whitish branches, especially conspicuous during the winter after the leaves have fallen, furnish an easy means of identification. Blue oak is a common tree of the foothill regions of California, but is found only at the lower elevations in Sequoia National Park.

Description.—Tree 20 to 60 feet high with round top and ashy-gray scaly bark; leaves oblong, 1 to 3 inches long, bluish-green above, pale beneath, the margins smooth or with a few broad rounded teeth; acorns oval, ¾ to 1½ inches long, tapering to a point, set in a shallow cup.

Occurrence.—Sequoia, present, 1,500 to 5,500 feet: Ash Mountain; Potwisha; Hospital Rock.

3. **Highland live oak** (*Quercus wislizenii* A. DC.).—This oak is limited to California where it is known also as the interior live oak in contrast to the coast live oak of the coastal hills. It becomes a fine tree in the deep rich soil of sheltered valleys, but a stunted shrubby form also occurs on dry gravelly slopes or in dry rocky stream bottoms.

Description.—A vigorous, round-headed, evergreen tree, 25 to 75 feet high with a trunk 1 to 3 feet in diameter; leaves ¾ to 2½ inches long, flat, leathery, oblong, or elliptic, the margins smooth or with spine-tipped teeth, green and shining above, pale yellow-green below; acorn 1 to 1½ inches long, cylindric and tapering to the apex, often striped lengthwise with dark lines; cup with long, thin, reddish-brown scales covering ¼ to ½ of the nut.

Occurrence.—Yosemite, present, 2,000 to 4,500 feet: Merced River; near El Portal. Sequoia, common, 1,500 to 4,500 feet: Ash Mountain; Hospital Rock Road; Paradise Creek.

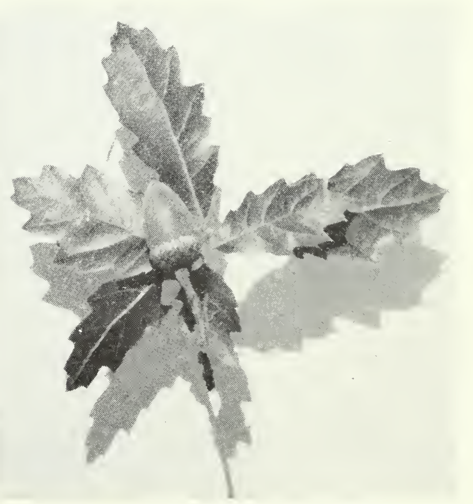

FIGURE 70.—Evergreen black oak.

4. **Canyon live oak** (*Quercus chrysolepis* Liebm.).—This oak is very variable in size and shape. It is usually a tree, but on high exposed ridges it is frequently a low shrub. The trees may be tall or short, with narrow or broad crowns, depending upon whether they grow in open or dense stands, and often have leaning or crooked trunks. Individuals in some unusually favorable locations in California have attained the height of 100 feet with a trunk diameter of nearly 6 feet. Canyon live oak is rather easily recognized by its whitish bark and stiff, shiny green leaves. The acorns have a characteristic turbanlike cup covered with a yellowish wool. The latter character has given the tree the common name, goldencup oak, which is preferred

in some places. It is also known as goldenleaf oak because the young leaves are covered with a yellowish powder on the under surface. Early settlers called it the maul oak because of its hard, tough wood which was used to make mauls (mallets) and handles for implements.

Description.—An evergreen oak with light-colored, scaly bark; leaves ¾ to 2 inches long, oblong, thick and leathery, very variable in both size and shape, toothed or not toothed, smooth above, lead-colored beneath, the under surface of the young leaves covered with a yellowish powder; acorn about ¾ to 1 inch long, abruptly pointed, the cup turbanlike, densely covered with a yellowish fuzz; wood heavy, tough, coarse to fine grained.

Occurrence.—Yosemite, abundant, 3,500 to 7,900 feet: Yosemite Valley; near El Portal; Tenaya Canyon; slope below, and to the south of, Half Dome; north side of Muir Gorge; southwest of Mount Starr King. Sequoia, abundant, 1,500 to 7,300 feet: Marble Fork of Kaweah River; Hospital Rock; Kern River Canyon north of Chagoopa Falls bridge.

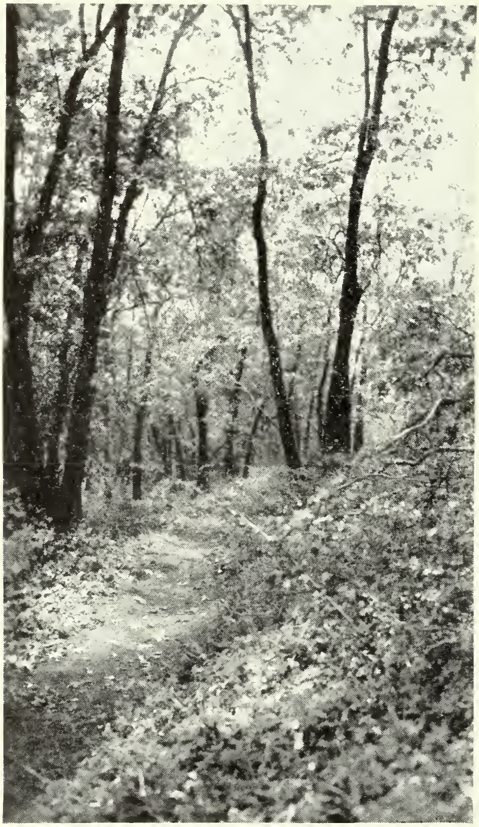

FIGURE 71.—Black oak type. Sequoia National Park.

5. **Evergreen black oak** (*Quercus morehus* Kell.) (fig. 70).—This oak has been found only in California in a few localities. Occasional specimens have been found on dry gravelly slopes and ridges in the foothills of Sequoia National Park. Evergreen black oak has been considered by some to be a cross between the California black oak and highland live oak, this supposition being based on the strong resemblance of the acorns to those of highland live oak, while the leaves are similar in shape and texture to those of the California black oak.

Description.—A semievergreen tree 25 to 50 feet high, or sometimes a shrub; leaves elliptic to oblong, 1½ to 4 inches long, dark green and glossy above, paler beneath, shallowly toothed, the teeth spine-tipped; acorns cylindric, about 1 inch long and ½ inch thick, tapering to a point, very finely hairy; cups with thin, closely appressed scales, enclosing from ¼ to ⅔ of the nut.

Occurrence.—Yosemite, rare: Hetch Hetchy Valley, along road; near El Portal. Sequoia, rare, 3,000 to 6,000 feet: Mouth of Paradise Creek; along road to Buckeye campground.

6. **California black oak** (*Quercus kelloggii* Newb.) (fig. 71).—California black oak is one of the principal oaks in the lower Sierra Nevada Mountains where it grows characteristically on high ridges and mountain slopes in and just below the ponderosa pine belt. It attains the largest size and has the largest leaves of any oak in the western national parks. The name, black oak, comes from the dark color of its bark, a feature common to several of the oaks which also have bristle-tipped lobed leaves and biennial acorns. Others with whitish bark are usually grouped together into what is called the white oak group. The leaves are quite variable in size and shape, but are all deeply cut into several sections with bristle-tipped teeth. This oak is especially attractive in the spring with the coming of the new leaves which are tinged with deep red as they break from the buds. The autumn coloration of the leaves adds much to the beauty of the landscape during the fall. The tree has for centuries supplied the Indians with acorns which were among their main articles of food during times past. The suckers, sprouts, and lower leaves make excellent browse for deer.

Description.—A graceful tree, 30 to 85 feet high, with a broad rounded crown; trunk 1 to 4½ feet in diameter, often bent and leaning; bark dark or blackish brown, deeply checked and furrowed below, smooth and grayish above; leaves 4 to 8 inches long, 2½ to 4 inches wide, shiny deep yellow-green and smooth above, paler beneath, deeply cut into several sharply-toothed sections, the teeth bristle-tipped; acorns about 1 to 1½ inches long, with rounded ends; cup large, ½ to 1 inch deep and about ¾ to 1 inch broad, covered with thin, ragged, overlapping scales.

Occurrence.—Lassen, present. Yosemite, abundant, 3,000 to 7,300 feet: Yosemite Valley; trail above Mirror Lake; Ahwahnee Hotel; southwest of Mount Starr King. Sequoia, abundant, 3,500 to 7,700 feet: Above Hospital Rock on Generals Highway; ridge south of Long Meadow.

BIBLIOGRAPHY

Abrams, Leroy. an illustrated flora of the pacific states. California, Stanford University Press, 1923. Vol. 1, pp. 1–536.

Allen, G. F. forests of mount rainier national park. United States Department of the Interior, National Park Service, 1922. 32 p.

American Joint Committee on Horticultural Nomenclature. standardized plant names. By F. L. Olmsted, F. V. Coville, *and* H. P. Kelsey. Salem, Mass., 1923.

Ashton, Ruth E. plants of rocky mountain national park. United States Department of the Interior, National Park Service, 1933. 156 p.

Bowman, Isaiah. forest physiography. New York, J. Wiley & Sons, 1911.

Brockman, Frank. the forests of mount rainier national park. Nature notes, Vol. 16, 1938. Mimeographed.

——— ——— plants of mount rainier national park. Nature notes, Vol. 16, 1938. Mimeographed.

Collingwood, G. H. knowing your trees. American Forestry Association, Washington, D. C., 1937.

Coulter, John M. (revised by Aven Nelson). new manual of botany of the central rocky mountain region. New York, American Book Company, 1909. 646 p.

Dayton, W. A. important western browse plants. United States Department of Agriculture (Misc. Pub. No. 101), 1931.

Degener, Otto. illustrated guide to the ferns and flowering plants of hawaii national park. Honolulu, *Honolulu Star Bulletin*, 1930. 312 p.

Dodge, Natt N. trees of grand canyon national park. Grand Canyon Natural History Association Bulletin No. 3, 1936.

Eliot, W. A. forest trees of the pacific coast. New York, G. P. Putnam's Sons, 1938. 565 p.

Fennemann, Neven M. physiography of the western united states. New York, McGraw-Hill Co., 1931.

Gilkey, H. M. handbook of northwest flowering plants. Portland, Oreg., 1936. 384 p.

Hanzlik, E. J. trees and forests of western united states. Portland, Oreg., Dunham Printing Co., 1928.

Harlow, W. M. *and* Harrar, E. S. textbook of dendrology. New York, McGraw-Hill Co., 1937. 527 p.

Hawbecker, A. *and* Patraw, P. M. check-list of the plants of grand canyon national park. Natural History Bulletin No. 6, 1936.

Hill, C. L. forests of yosemite, sequoia, and general grant national parks. United States Department of the Interior, National Park Service, 1928. 40 p.

Hillebrand, W. flora of the hawaiian islands. New York, B. Westermann & Co., 1888.

Illick, J. S. tree habits. American Nature Association, Washington, D. C., 1924.

——— ——— an outline of general forestry. New York, Barnes & Noble, Inc., 1935.

Jepson, W. L. a flora of california. Vols. 1 and 2. Berkeley, Calif., Students Co-operative Society, University of California, 1909; 1936.

——— ——— manual of the flowering plants of california. Berkeley, Calif., Associated Students Store, University of California, 1925. 1,170 p.

KIRKWOOD, J. E. NORTHERN ROCKY MOUNTAINS TREES AND SHRUBS. Stanford University Press, Stanford University, California, 1930. 340 p.

LAMB, S. H. TREES OF THE KILAUEA-MAUNA LOA SECTION, HAWAII NATIONAL PARK. Natural History Bulletin No. 2, 1936. Mimeographed.

LONGYEAR, B. O. TREES AND SHRUBS OF THE ROCKY MOUNTAIN REGION. New York, G. P. Putnam's Sons, 1927. 244 p.

——— ——— THE TREES OF CALIFORNIA. San Francisco, Calif., Cunningham, Curtis & Welch, 1909.

MATHEWS, F. S. FIELD BOOK OF AMERICAN TREES AND SHRUBS. New York, G. P. Putnam's Sons, 1915. 465 p.

MATTOON, W. R. FOREST TREES AND FOREST REGIONS OF THE UNITED STATES. United States Department of Agriculture (Misc. Pub. No. 217) 1936.

McDOUGALL, W. B. *and* BAGGLEY, HERMA A. PLANTS OF YELLOWSTONE NATIONAL PARK. United States Department of the Interior, National Park Service, 1936. 160 p.

McMINN, H. E. *and* MAINO, E. AN ILLUSTRATED MANUAL OF PACIFIC COAST TREES. Berkeley, Calif., University of California Press, 1935. 409 p.

MORTON, B. R. NATIVE TREES OF CANADA. Forest Service Bulletin No. 61, Ottawa, Canada, J. O. Patenaude, 1933. 216 p.

PATRAW, P. M. CHECK LIST OF THE PLANTS OF GRAND CANYON NATIONAL PARK. Grand Canyon Natural History Association Bulletin No. 6, 1936.

PERNOT, J. F. FORESTS OF CRATER LAKE NATIONAL PARK. United States Department of the Interior, National Park Service, 1916. 40 p.

PIERSON, F. W. TREES AND SHRUBS OF THE SAN GABRIEL RANGE. Pasadena, Calif., Pasadena City Schools, 1935.

PIPER, C. V. *and* BEATTIE, R. K. FLORA OF THE NORTHWEST COAST. Lancaster, Pa., New Era Printing Co., 1915. 418 p.

RAMALEY, FRANCIS. COLORADO PLANT LIFE. Boulder, Colo., University of Colorado, 1927. 229 p.

REHDER, ALFRED. MANUAL OF CULTIVATED TREES AND SHRUBS HARDY IN NORTH AMERICA. New York, Macmillan Co., 1927. 930 p.

ROGERS, J. E. THE TREE BOOK. New York, Nature Library, Vol. 9, 1912.

RYDBERG, P. A. FLORA OF THE ROCKY MOUNTAINS AND ADJACENT PLAINS. New York, New York Botanical Garden, 1922. 1,141 p.

——— ——— FLORA OF COLORADO. Fort Collins, Colo., Agricultural Experiment Station, 1906.

SARGENT, CHARLES SPRAGUE. MANUAL OF THE TREES OF NORTH AMERICA. Boston, Mass., Houghton Mifflin Co., 1933. 910 p.

SAUNDERS, C. F. USEFUL WILD PLANTS OF THE UNITED STATES AND CANADA (3RD EDITION REVISED). New York, R. M. McBride & Co., 1934. 275 p.

STANDLEY, PAUL C. PLANTS OF GLACIER NATIONAL PARK. United States Department of the Interior, National Park Service, 1926. 110 p.

STUHR, E. T. MANUAL OF PACIFIC COAST DRUG PLANTS. Lancaster, Pa., Science Press, 1933. 189 p.

ST. JOHN, HAROLD *and* WARREN, F. A. PLANTS OF MOUNT RAINIER NATIONAL PARK. American Midland Naturalist, Vol. 18, 1937, pp. 952–85.

SUDWORTH, GEORGE B. FOREST TREES OF THE PACIFIC SLOPE. United States Department of Agriculture, 1908.

——— ——— CHECK LIST OF THE FOREST TREES OF THE UNITED STATES. United States Department of Agriculture (Misc. Circular No. 92), 1927.

——— ——— POPLARS, PRINCIPAL TREE WILLOWS AND WALNUTS OF THE ROCKY MOUNTAIN REGION. United States Department of Agriculture (Technical Bulletin No. 420), 1934.

TIDESTROM, IVAR. FLORA OF UTAH AND NEVADA. Contributions to the United States National Herbarium, Vol. 25, 1925, 665 p.

Van Dersal, W. R. native woody plants of the united states. United States Department of Agriculture (Misc. Pub. 303), 1938.

United States Forest Service. range plant handbook. United States Department of Agriculture, 1937.

Werthner, W. B. some american trees. New York, Macmillan Co., 1935. 398 p.

Wooten, E. O. *and* Standley, P. C. flora of new mexico. Contributions to the United States National Herbarium, Vol. 19, 1915. 794 p.

Yanovsky, Elias. food plants of the north american indians. United States Department of Agriculture (Misc. Pub. No. 237), 1936.

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